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RESEARCH FOR THE PLANTING INDUSTRIES.

In the present number is included the gist of an address which was given before the Annual General Meeting of the Planters' Association of Ceylon on the subject of the organization of scientific research for the Planting Industries—Tea, Rubber and Coconuts. An attempt was made to define where the duty of the State began and ended and what was the duty of an industry to itself. In proposing certain definite lines of work as the duty of the State and others as being the duty of the Industries, attention was given to the policy which has been followed in other parts of the Empire, and stress laid upon the particular requirements of Ceylon.

In the past it has been most frequently urged that the scientific assistance to the agricultural industries was the duty of the State. The Government of Ceylon has recognised its duty to agriculture in providing for agricultural research, but the demands of the industries have at times been in excess of what it was found possible to agree to. This was recognised when the Rubber Research Scheme was launched and was made plain when the Tea and Coconut Industries clearly indicated their desire for more work to be undertaken.

In Ceylon, the Government cannot overlook its duties to its agricultural industries in regard to pests and diseases. It has the history of the coffee disaster before it and it has to safeguard itself against any other disease becoming a danger to its main agricultural crops. There are some diseases in Ceylon which may become a menace to the welfare of some of its crops, and it is the duty of the Government to see that these are watched and that satisfactory control measures are enforced.

No State dependent upon its agricultural industries for its Revenue can shirk its duty in this direction and no industry should be entrusted with such a duty. It is neither good for the State nor for the Industry. Certain legislative enactments for the control of pests and diseases of agricultural crops are in force and these can only be administered through Government machinery.

The administration of these enactments depends upon an exact knowledge of the life histories of the various pests and diseases and thus fundamental research must be the duty of the State Department which is called upon to administer these legislative measures.

The Technology of an industry, especially of any manufactured product is, however, clearly the duty of the Industry itself. Here the industry should provide for research, and it should also provide for those investigations which are necessary in the application of control measures against pests and diseases upon particular areas or estates, and for the investigation of manuring problems.

The combination of the Government and the Industry appear to be most desirable under Ceylon conditions and it is expected that co-ordinated Research Schemes for the Tea, Rubber and Coconut Industries will be established.

The Rubber Research Scheme has now been in operation for a number of years. It is supported by Government, the Rubber Growers' Association, and by voluntary subscriptions from Ceylon estates. These latter subscriptions have increased in recent years but there is a strong feeling in certain quarters that the whole of the rubber industry should be called upon to contribute to such a scheme. This can best be done by means of a cess on exports and this is the policy which has been adopted by Malaya in connexion with its proposed Rubber Research Institute. In Malaya it has been decided that this additional cess on exports should not come into force during the period of Restriction, and it is probable that the same policy might be equally well adopted for Ceylon. In the meantime, the Tea and Coconut Research Schemes can be proceeded with.

RUBBER.

RESEARCH WORK ON THE PLANTATIONS.

MAJOR B. J. EATON, O.B.E., F.I.C.

Following is a part of a Paper read before the London Section of the Institution of the Rubber Industry, by Major B. J. Eaton, O. B. E., F. I. C., Chemist of the Department of Agriculture, S. S. and F. M. S., at its meeting on 1st December, 1924, Mr. P. J. Burgess presiding:—

Although no hard and fast lines can be drawn between certain branches of scientific work, and both field and laboratory experiment have frequently to be combined to obtain the results required, for the sake of convenience in discussing plantation research, it is disirable to adopt such distinctions, and I therefore propose to discuss briefly the various problems under different headings as follows :—

(1) Research in the field or agricultural research which involves.
- (a) Manurial or fertiliser trials with cover crops.
- (b) Experiments on methods of tapping.
- (c) Physiolological experiment (requiring both field and laboratory experiment).
- (d) Field experiments on pests and diseases.
- (e) Field experiments on seed selection and vegetative reproduction.

(2) Laboratory research involving.
- (a) Methods of preparation of raw rubber and coagulation of latex.
- (b) Constitution of latex and influence of various constituents on the properties of raw rubber.
- (c) Vulcanization researches on latex and rubber.
- (d) Preservation and transport of latex.
- (e) Pests and diseases, *i. e.*, mycological, bacteriological and entomological researches.
- (f) Investigation of soils.

I have not tabulated the above in any definite sequence, either in respect of the crop with which we are dealing or of their relative importance.

In fact a problem of major importance to the industry at one period may become of minor importance at another, and *vice-versa*. For example, when I was first appointed in Malaya, the principal problem which was agitating both the rubber manufacturer and the producer was the variability of the raw plantation product. As far as I have been able to gather this particular problem is to-day by no means so acute, although I venture to suggest that our raw product to-day is much more uniform than it was about ten to fifteen years ago, and that the improvement has been effected by our knowledge of some of the causes of variability obtained by scientific research.

About six or seven years ago the life of the rubber scientist in Malaya —fortunately not the chemist in this case—was a burden, owing to the prevalence of the disease, the name of which I have no doubt is known to you all—brown bast.

Our botanists, physiologists and plant pathologists were maligned in the Press and by the planter, and generally considered to be a very ignorant lot of scientists. At present we hear very little of brown bast, and it would seem to be the case that this obscure disease is probably physiological in character, and was brought about or its incidence increased by our methods of tapping, which were excessive.

To-day the problem which is the "bugbear" of the scientist is vegetative reproduction and its probable effects. To-morrow who can say what may be our principal *piece de resistence*? However, this again is a digression, except that the problems to which I have referred indicate that problems are continually arising, and that scientific knowledge and research is always a progression.

Let us therefore deal briefly with a few of the problems which have been tackled scientifically on the plantation, as well as those which still require attack or further attack.

FIELD EXPERIMENTS ON FERTILISERS AND GREEN COVER CROPS.

The position to-day in respect of our knowledge of the effect of fertilisers in the field on yield of latex or the improvements in health and vigour of the rubber tree is not very advanced. Although very few systematic experiments have been carried out in any country in which rubber is at present grown such experiments as have been conducted do not indicate that any benefit has been derived from a general policy of applying manures. Unfortunately, owing to the large field experimental error and the variability in yield of individual rubber trees which we now know is so great, fertiliser trials require considerable duplication before reliable deductions can be drawn.

We know that very little is removed from the soil, in the harvesting of the rubber crop, and therefore the application of fertilisers must be effective chiefly in maintaining or increasing the natural vigour of the tree. I am also of opinion from my experience that where the rubber tree is growing on virgin soil, originally under jungle, and where soil erosion has been prevented from the early history of the estate, land under rubber should not deteriorate, and is unlikely to respond to any manurial treatment.

On the other hand we undoubtedly have cases in which the application of manures will be extremely beneficial, but these cases are usually exceptional, and due either to the planting of rubber on originally poor land, or on land which has been rendered poor by years of cultivation of other crops, with no treatment or amelioration. Such areas are to be found in the southerly parts of Johore and on the island of Singapore, in Malaya, where the land has a long previous history of cultivation with pine-apples, tapioca and gambier.

One of the most interesting cases of improvement of yield of rubber by manurial treatment has come under our notice recently, and this also is an exceptional case.

It has been proved by laboratory experiments that the soil in question has little or no powers of ammonification or nitrification, and the laboratory experiments have been confirmed by field experiments, in which it has been shown that the only fertilisers which were effective on the land in question are ammonium salts or nitrates.

The present yield of rubber from this soil is poor, and the field trials have shown that increases of 50 to 100 per cent. can be obtained by the application of ammonium salts or nitrates costing about £2 per acre per annum.

I have stated that this is a special case, and I want particularly to emphasise the fact that we cannot apply general principles loosely.

On theoretical grounds, in the absence of investigations, one would have thought that such easily soluble fertilisers as ammonium salts or nitrates would have been of little value in the tropics in the case of this crop, owing to the probable rapid loss by leaching, on account of the tropical rains.

Another interesting fact which emerged from these experiments was that the fertiliser had little or no effect when a green cover crop was present on the land. This is undoubtedly due to the preferential absorption of the fertiliser by the cover crop.

All experiments of this kind require rigid scientific control and analysis of results on a mathematical basis and the duplication of plots, as well as a prior knowledge of the comparative yields of all the plots on which the experiments are to be carried out, on account of the variability of the plants on the plots.

(Note.—Abstract of certain manurial experiments read and commented on and experiments shown to be valueless.)

TAPPING EXPERIMENTS.

Tapping experiments are perhaps one of the principal field experiments which can be carried out by a careful, observant and keen planter, although there are many pitfalls, and only after some years of experience even are some of these realised. I believe Morgan first drew attention to the personal error of the tapping cooly in all tapping experiments, and yet many planters should have realised this factor at an early stage. Any tapping experiment is useless as a scientific experiment unless this factor is eliminated. This also applies to fertiliser trials and any other field experiments on the rubber tree, in which the result to be obtained has to be measured in terms of yield of latex or rubber, and illustrates one of the great difficulties of scientific field work on this crop.

Provided a planter has realised all the variable factors concerned, satisfactory tapping experiments can be carried out as well by the planter as by the scientifically-trained investigator.

PHYSIOLOGICAL RESEARCH.

Physiological research is at present much needed in connection with research on the plantation. As I have already mentioned, it appears from evidence already obtained that the disease known as brown bast is a physiological disease, the incidence of which is related to the method of tapping.

Excessive tapping undoubtedly increases the incidence of brown bast, and, as would be expected in a disease of this character, some trees are more resistant than others.

Incidentally one might throw out the suggestion of the possibility of high yielding trees or their high yielding progeny obtained by vegetative reproduction being more susceptible to this disease, *i.e.*, if the actual yield of latex is in any way responsible for the condition. This, however, can only be proved by actual experience.

There is no doubt, however, that further knowledge of the physiology of the rubber tree will assist our investigations in numerous directions.

INVESTIGATION OF PESTS AND DISEASES.

As we all know, the rubber tree, like all economic crops grown under artificial conditions in large contiguous areas, is subject to various physiological diseases and insect pests. Considerable investigation of a successful character has been carried out in all rubber-growing countries in the East, in connection with most of the diseases at present known to attack the tree.

Most of our diseases are indigenous to the country, and are relics of the original jungle. This also applies to various stem and branch diseases of the tree, as well as to root diseases.

So far, no great difficulties have been encountered in dealing with the fungoid diseases hitherto encountered, with the exception of mouldy rot (*Sphæronema fimbriatum*) of the tapped surface, which has not yet yielded to treatment perhaps so readily. It must be remembered, however, that any disease attacking the trunk of the tree which is required for tapping purposes, can only be treated by antiseptic methods, *i.e.*, by painting or washing with fungicides, and tapping has to be stopped during treatment of the disease.

Although the period may come when the plant-breeder has produced disease-resistant strains of rubber trees as well as other economic plants, it can be stated I think with certainty that had the rubber plantations of the East not been assisted from the commencement almost by the scientific advice of the plant pathologist, the plantation industry would not have been the great success which it is to-day. This is probably forgotten or perhaps not often considered or realised by those whose principal interest is the money which they have invested in the industry.

At present perhaps our methods of treatment of diseases, especially of permanent crops like the rubber tree, savours rather much of drastic surgery rather than of preventive methods.

Fortunately, at present the rubber tree has not been attacked to any great extent by any serious insect pest, although such possibility must not be overlooked, especially when we realise the ravages and losses caused by insect pests on many other economic crops.

FIELD EXPERIMENTATION ON SEED SELECTION AND VEGETATIVE REPRODUCTION.

I have mentioned previously that one problem may loom as the most important to the industry at one stage, and another problem may subsequently take the place of primary importance.

I think we must all admit that the great problem which is agitating the minds of all planters and scientific investigators concerned with the plantation rubber industry at the present is that of experimental work having as its object the production of trees giving an improved yield of latex and rubber.

It is perhaps strange that this important problem has only come to the fore during the last three or four years, although the big differences in yields of individual trees on any estate must have been known to the planter for years, yet few actual measurements were made which would indicate these differences till a number of years after the plantation industry became an assured success.

Several factors may be responsible for this. In the early days it was an invariable practice to add water to the tapping cups, and, this obscured variation in yield. Secondly, the industry grew so rapidly and scientific knowledge was not able at first to keep pace with it. Thirdly, it was realised that reproduction by seed selection must be a very slow process, and methinks our botanists perhaps shied at a problem which was not likely to be solved in their life time, or at any rate during their period of useful work in the tropics. It is perhaps curious, however, that no earlier attempts appear to have been made in vegetative reproduction by bud-grafting or other well-known methods. It is probable that most of our botanical and horticultural investigators were of opinion that since the trunk or the stem was the essential part of the plant required in this instance, and not the flower or fruit, as in most previous cases in which vegetative methods of reproduction have been applied, such methods might be of no practical utility.

Whatever the cause of the early failure to commence work of this character, we are at present all convinced of its necessity, although the scientific investigator still considers that the problem is entirely an experimental one, and that similar results can be obtained possibly by other methods.

In any case, although we are all convinced of the necessity of investigation and experiment on these lines, it must be realised that any individual syndicate or company having available capital and land, and desiring to plant bud-grafted trees, is doing so entirely as an experiment or speculation, since our present knowledge of the possible results is negligible.

The safest method of field experiment to adopt in such a case, even although it will cost rather more, is the system which has already been adopted by one large company, *viz.*, to plant alternate rows of stumps from "selected" seed and bud-grafts, and to plant at such a density that thinning-out can be carried out in the early stages of growth based on several methods of testing and experiment.

By this method we have two strings to our bow. In any case, in view of our present knowledge of variability in yield of individual trees, I am not an advocate of wide planting in the first instance, especially on virgin land, on which, unless the land has been thoroughly cleared of all jungle stumps and roots, losses due to root diseases are certain to occur. Such diseases are no respectors of the best trees, and it is therefore advisable to plant a sufficient stand of trees to allow for such losses, and to enable thinning-out

to be carried out at an early stage on the more scientific basis of yield data than by haphazard methods of appearance.

In concluding this brief *résumé* on field investigations I wish especially to emphasise the fact that any Institution of Rubber Research in a rubber-growing country should either possess a large area on which numerous types of such experiments can be conducted, or must obtain lien over areas on a number of estates belonging to companies or individuals.

There are no other companies which have the large areas owned by the H.A.P.M. in Sumatra, and that company is in a unique position to carry out field experiments. In its case, however, all field experiments are charged to research account, and all labour and other expenses incurred by the manager of any division of the area owned by this company are allocated to central research expenditure.

In the case of a Rubber Research Institute, in the absence of sufficiently large areas for field experiments which would involve large capital costs, the best solution of such problems would probably be the drawing up of definite agreement between the Institute of any particular estate in connection with the particular experiment involved, and the allocation of all expenditure on the area concerned, over and above the usual routine cost to the Institute. This would ensure continuity in the experiment, even in the event of change of management which might involve change of policy.

In the case of any loss of rubber, *e.g.*, due to a particular tapping experiment, the estate would have to be compensated, and the reparation or compensation included as a part of the cost of the experiment.

A Rubber Research Institute must have complete charge, if necessary, of such experiments.

LABORATORY INVESTIGATIONS.

In most branches of agricultural science, laboratory and field investigation must progress hand in hand. In some cases this is absolutely essential, while in others the combination is of great advantage.

In my own special branch of science and its application to the plantation rubber industry I have found this combination of laboratory investigation and field or factory observation of the greatest advantage.

I venture to suggest, for example, that the elucidation of the cause of variability of plantation rubber in respect of rate of cure would have been extremely difficult to any chemist not working on the spot. The great advantage in this particular piece of research was a knowledge of the history of the raw rubber, from the tree to the vulcanized product.

METHODS OF PREPARATION OF RAW RUBBER AND COAGULATION OF LATEX.

As we all know, the chemistry of rubber is still a very obscure problem, but as far as many of the vagaries of the raw material are concerned, which are caused by differences in the composition of the commercial product, which is not pure caoutchouc, we have a fairly delicate physical method of tracing certain of these chemical differences by means of the behaviour of the vulcanized product.

As in the case of many chemical changes which are accelerated by what we describe as catalysts, so in the case of the changes in raw rubber induced by its combination with sulphur under various conditions of

temperature, it has been found that certain catalysts, or, as they have been termed in the rubber industry, accelerators have a marked effect in increasing the rate of combination of sulphur with raw rubber, which is indicated not only by the vulcanization coefficient or ratio of combined sulphur in the vulcanized rubber but also readily by the physical characters of the product, unless these are obscured by the action of other substances. We also know that comparatively small proportions of these substances have a marked effect, which also means that the separation and indentity of such substances when present or formed in the raw rubber is attended with considerable difficulty.

We also know, from our researches that some substances, especially "strong" acids such as the mineral acids, behave as negative catalysts, if such a term might be used, that is, their presence in rubber retards vulcanization.

Great care, therefore, has to be taken in all experiments on raw rubber in controlling the treatment to which it is subjected. I have recently shown, for example, the marked influence of comparatively small quantities of arsenic oxides on the vulcanization process.

Although we have already made considerable progress during the last ten years in our knowledge of the behaviour of the plantation product in the manufactory, we have still much to learn in various directions.

I am not sure at the moment whether the Institution of the Rubber Industry is a combined scientific and industrial institution which is concerned with all aspects of the rubber industry, or more particularly with the finished raw product, its preparation on the estate and the condition in which it reaches the market. If the latter, especially I should welcome its assistance in placing before us in the East any of the problems in connection with the raw product which interest or affect the rubber manufacturer and which may not be understood.

It must be remembered that as far as the finished raw product is concerned, our investigations in the East must be guided generally by the requirements of the manufacturer and his difficulties, if he has any ; at the same time, for scientific investigators, there is also always plenty of what we might describe as pure research on this product, which we can carry on in the absence of any lead from the manufacturer, or without immediate application to any special problem which may concern him.

If no complaints are forthcoming, we can only assume that there is nothing wrong with the product which the estates are putting on the market, or that the manufacturer is too apathetic or busy to worry about them.

In our chemical investigations in the plantation rubber industry we have also to assist the planter to satisfy the buyer or broker. I hope if there are any present at this lecture they will forgive my remarks. In any case, I can state that the London market does not appear to be so severe on the producer as the Singapore market in respect of so-called or alleged defects in the raw product.

We all realise, of course, that the good appearance of the finished product indicates generally care in preparation; on the other hand, a finely-knit, very evenly finished thin crepe may indicate excessive working, or in any case has usually involved a waste of time on the estate, since colour in pale crepe and not such factors as closeness of texture is the quality required. In addition to other qualities such as adhesiveness, or strength after vulcanization.

The problems which I have indicated under the sub-headings : (a) Coagulation of latex and methods of preparation of raw rubber,

(b) Constitution of latex and influence of various constitutents on the properties of raw rubber. (c) Vulcanization researches on latex and rubber, and (d) Preservation and transport of latex—are all closely connected problems requiring investigation by the chemist.

In dealing with the properties of raw rubber we must carry out vulcanization researches and also investigations on the effect of various methods of coagulation, in which investigation of the nature of the coagulation process itself is involved, and also investigations on the constitution of latex.

The comparatively recent application of the liquid latex in certain directions has also involved research on methods of preservation of this product for purposes of transport and storage.

This also requires investigation of the composition of the latex and the possible changes which may occur on storage.

The fact that in the transport of latex we are paying freight on 60 to 70 per cent. of water has also directed attention to the possibility of concentration of latex to a paste or dry powder capable of being reverted to latex of any desired concentration by the addition of water.

It is known that, when latex is evaporated, coagulation takes place, but recent investigations by Hauser have shown that by the addition of certain protective colloids latex can be evaporated and the evaporated product reverted to latex.

At the moment, therefore, we are not without problems which require investigation and which are of practical interest to the rubber manufacturer in many directions.

Investigations on the constitution of latex can be carried out most satisfactorily only in rubber-growing countries, owing to the changes which take place in preserved latex. There is no doubt that certain important changes do occur in latex which has been preserved with ammonia and stored for some time. Comparatively large quantities of ammonium magnesium phosphates separate, and this may be due to actual breaking down of some organic phosphorus compounds in the latex. Ammonia as a preservative also has an effect on the rate of vulcanization of the rubber, possibly due to its action on the natural accelerators present in the latex. We also know that the amount of ammonia required to preserve latex is considerably more than the amount required to neutralise any acidity present or likely to be formed by the decomposition by micro-organisms of the carbohydrates present in the latex into organic acids.

In my opinion the excess of ammonia required is an amount sufficient to destroy or inhibit the action of the micro-organisms present in all latex which is not collected under sterile conditions.

Further investigation which should yield results of value are required also on the lines of recent work carried out by Whitby on the "acidity" of raw rubber.

Finally, a problem which we understand causes trouble to the manufacturer at present is the variability in milling quality of the raw product, and I hope to be able to start some definite investigations on this problem from the plantation side of the industry.

The manufacturer is the only person who can supply information as to the variability in the raw material which he obtains on the market, and, on the plantation side of the industry, the scientific workers are in a good position to investigate the causes of such variability.

SOIL INVESTIGATIONS.

I have left until last another problem with which the chemist and biologist has to deal in connection not only with the plantation rubber industry, but in the case of all agricultural practice in every country, namely, soil

investigations. In the older countries such as England, where the history of the cultivation of certain areas and soils is known over a period of years, and where scientific methods of investigation have also been applied for some years, we are aware both from practice and the correlation of certain scientific facts with such practice what certain soils are capable of growing.

Unfortunately, our knowledge of soils in any tropical country is at present meagre, since scientific investigation in the tropics is a thing of recent growth.

My experience also teaches me that in many respects the application of certain deductions from facts obtained from the investigation of soils in temperate climates is also inadmissible. We know, for instance, that, owing to the high humidity and temperature in a climate such as that of Malaya, the micro-flora and fauna of the soil must be very active at all times and that the problem of "available" plant food, produced by the activities of soil micro-organisms must be very different from that of a soil in a temperate climate.

Similarly, we know from experience the soils in our own climate in England, which are most suitable for a whole series of certain crops. We know, of course, now the soils which are most suitable for rubber cultivation but we have no very definite scientific facts in respect of such soils. We can definitely state what are undoubtedly bad soils, but this identification is based chiefly on the physical character of the soil.

Generally speaking, we know that "acidity" of a soil renders it unsuitable for most crops in this climate, while in Malaya most soils are "acidic" in character and free lime or calcium carbonate is conspicuous by its absence. We have no evidence from any experiments that liming is of any real value for rubber cultivation, apart from its physical action on certain "heavy soils.

There is thus much investigation of a fundamental character required in connection with soil problems in the tropics. As far as the Rubber Industry is concerned, however, if the rubber tree is planted on virgin soil and the soil is properly conserved in the first instance so that the valuable surface soil is not washed into the valleys from undulating or hilly areas by the heavy tropical rainfall, I am of opinion that the soil on a rubber estate should improve rather than deteriorate.

FURTHER OBSERVATIONS.

Since writing this paper one or two further observations have occurred to me to which I should like to make reference.

A problem with which we have had to deal recently is the investigation of "rubber" oil obtained by the dry or destructive distillation of lower-grade rubber, which under present restriction is not worth exporting. I am, however, not very optimistic in regard to the possibilities of such an oil as a fuel for internal combustion engines, *i. e.*, as a substitute for petrol, or kerosene except possibly for local use. The present price of petrol at 1*s.* 6*d.* per gallon, is equivalent to less than 3*d.* per lb. which means that the raw material from which the oil is obtained must be of little or no value if we take into account cost of manufacture, packing and freight charges on the oil. There may, of course, be other directions in which the oil can be used.

Recently, also, we have had to investigate samples of locally manufactured rubber goods, since questions of restriction and customs are involved in connection with the export of such goods and their rubber content.

The sale of latex from a number of estates has also provided us with further problems in connection with the "rubber" content of preserved latex, owing to changes which appear to take place in latex to which ammonia is added as a preservative.—The Malayan Tin and Rubber Journal, Vol. XIV. No. 3.

OIL PALMS.

ASSURED FUTURE FOR THE OIL PALM.

A LARGE-SCALE PLANTATION CROP.

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During the last twenty years the principal agricultural industry in the Malaya has been the cultivation of the Para rubber tree as a plantation crop. Coconuts and rice are the two other most important crops, but the areas under cultivation are in each case much smaller than the area under rubber cultivation, while rice cultivation is entirely a native industry. Notwithstanding the marvellous and romantic success and progress of the plantation rubber industry it has been felt, however, that in respect of agricultural industries Malaya has far too long had all her eggs in one basket. A warning to this effect was expressed nearly twenty years ago by the late Sir John Anderson, then Governor of the Straits Settlements and High Commissioner of the Federated Malay States. Owing to the great financial success of the plantation rubber industry no attention was paid to this and subsequent warnings until the severe slump in the price of raw rubber during 1921-22. The possibilities of other crops were not considered, and any available capital for agriculture was still invested in the plantation rubber industry.

In 1918 the F.M.S. and S.S. Department of Agriculture, one of whose functions is to consider and advise on the possibilities of crops suitable to the conditions of the country, drew attention to the African oil palm as a crop suitable for cultivation under plantation conditions in Malaya. As is well known to all who are interested in tropical agriculture, this palm is indigenous to several of our West African colonies but like the Para rubber tree, which is indigenous to South America, no attempt appears to have been made to cultivate the crop in the African colonies, and until recently nothing was done to improve the native methods of extraction and preparation of palm oil—one of the products of the oil palm fruit—either in respect of increasing the yield of oil or improving the quality by the application of modern scientific methods. This is probably due chiefly to the fact that the application of scientific principles to the problems of agriculture in most of our tropical colonies is of recent growth. The consequent lack of information of suitable methods of dealing with such a crop has also without doubt retarded the cultivation of the crop on a plantation scale.

THE APPLICATION OF SCIENCE.

The shortage of animal fats during the war has given an impetus to the problem of the utilisation of vegetable oils and fats for edible purposes, and also for other important industrial applications. The application of scientific knowledge to the extraction and refining of vegetable fats and oils has also

resulted in a marked improvement in the quality of such oils and fats for edible purposes. The two principal vegetable oils or fats used for edible purposes are coconut oil and palm kernel oil (the oil obtained from the kernel of the nut of the oil palm fruit). Until recently palm oil, which is obtained from the fleshy fibrous pericarp (outer layers) of the oil palm fruit, has been used for various industrial purposes, such as the manufacture of soap, candles, lubricating greases, and in the manufacture of tinplate. The native-prepared palm oil, exported from the West African colonies, has been of inferior quality, due to the primitive methods of collection and extraction and unsuitable for edible purposes. Scientific investigation has shown, however, that a very high grade palm oil can be obtained by methods which are economical and especially suited to the collection and treatment of the crop on a plantation scale.

In 1918, when attention was first directed to the possibilities of this crop in Malaya, one small estate was already in existence in the Federated Malay States. The area under cultivation on this estate has since been increased, and at present nearly 1,000 acres are in bearing, while the area under cultivation on this estate is being increased to 2,000 acres. At the present time between 5,000 and 6,000 acres of oil palms have been planted in Malaya.

The oil palm was introduced into the Dutch East Indies (Java and Sumatra) as long ago as 1848, but, as in Malaya, did not receive any serious attention as a plantation crop until about ten years ago. Since this period, however, considerable extention in cultivation has taken place, and it is estimated by Dr. Rutgers, Director of Agriculture, Commerce, and Industries of the Dutch East Indies, that the area planted in the east coast district of Sumatra amounted to 28,000 acres early in 1922. These facts show that our Dutch agricultural friends have not been slow in investing capital in this enterprise.

As a major agricultural industry, the writer and others are of opinion, from the information already available, that the oil palm offers the most promising possibilities as a large-scale plantation crop for Malaya. One of the principal difficulties until recently has been the problem of extraction of a high-grade palm oil on a large scale, but this difficulty has now been solved by the construction of British machinery of a very satisfactory type for the extraction of oil on both a large and small scale, so that the cultivation of the crop can be undertaken by the individual proprietor with small capital as well as by a company or syndicate with sufficient capital for an estate of from 1,000 to 2,000 acres or more.

In this article it is not possible to enter into minute detail in respect of methods of cultivation, harvesting of the crop, and extraction and preparation of the oils, but to give an outline only of the procedure necessary. Further detailed information is contained in an article published recently in the *Malayan Agricultural Journal* (Vol. XII, Nos. 6-7, June-July, 1924) issued by the Department of Agriculture, F.M.S. and S.S., and obtainable at the Malay States Information Agency, 88, Cannon Street, London, E.C.4. Advice can also be obtained from the Secretary for Agriculture, F.M.S. and S. S., Kuala Lumpur, Federated Malay States. A pamphlet dealing with the land regulations and containing information in respect of premia and rent on

land can also be obtained from the Malay States Information Agency, while the assistance and advice of the Department of Agriculture is always available in connection with the selection of suitable available land and the investigation of soils suitable for the crop.

SELECTION AND SUITABILITY OF LAND.

The most suitable soil for the cultivation of the oil palm is an alluvial loam with a clay subsoil. A light sandy soil and swampy soil are considered unsuitable. There is no doubt that the palm requires a good supply of water, and, if grown on undulating land, silt pits, blind contour drains, or terraces should be constructed in order to hold up the rainfall and prevent soil erosion, which results in the loss of valuable surface soil. The flat coastal areas of Malaya and similar land available along certain river banks are very suitable, if properly drained. In low-lying land it is advisable to cut suitable main drains through the area selected as soon as possible after the jungle is felled.

To those having capital but no knowledge of Malaya the best advice to offer in regard to the selection of land is that an experienced planter in the country should be employed and that his advice should be supplemented by advice from the Department of Agriculture in respect of the soil on any land prospected. It might be stated here that most of the suitable land available for planting is situated in the Federated Malay States, the State of Johore, and the Federated States. Little or no suitable land is likely to be available in any part of the colony of the Straits Settlements.

The cost of planting oil palms and bringing the crop into bearing will be very similar to the cost of planting coconuts, although returns from the oil palm will commence earlier than in the case of coconuts, since the palm comes into bearing in the third or fourth year, whereas coconuts, even in Malaya, do not usually commence to yield any crop till the sixth year. The cost of planting will include such operations as the felling, burning, and clearing of jungle, drainage, cost of seed or seedlings, preparation of nurseries, holing and planting, weeding, and general upkeep.

The ultimate aim in scientific work on this problem will be to produce fruit with a maximum amount of pericarp having a high palm oil content and a thin-shelled nut containing a large kernel with a high content of palm kernel oil.

CULTIVATION AND PLANTING.

The palm is propagated from seed which is planted in suitably prepared nursery beds consisting of nearly pure sand about one foot deep. Ripe fruit only should be selected, and after removing the pericarp (outer fleshy and fibrous layers of the fruit) the nuts should be planted at once just below the surface of the soil. The seed germinates very slowly, even in the case of seed from fresh ripe fruits, so that unless seedlings can be purchased from other estates the preparation of nursery beds and the planting of seed should be one of the first operations on the estates. The nursery beds should be exposed to the sun and kept moist by constant watering.

When the two-leaf sheaths appear about the ground, which may not be for two to three months, the seedlings are removed from the nurseries and planted about 1 to 1½ feet apart in another prepared nursery bed on flat land,

where they remain until ready for transplanting in the field, which may be from eight to ten months later. After the jungle has been felled and burned and the land cleared the seedlings are planted in the field about 30 ft. by 30 ft. apart triangular, giving approximately 55 palms per acre. The holes for planting should be dug about 2 ft. square by 2 ft. deep and filled with good surface soil, and the seedlings should be planted so that the base of the leaves is just above the soil surface. The area for several feet round each palm should be forked three or four times per annum. The whole area should either be kept free from weeds or suitable green (leguminous) cover crops should be planted. If the land is clean-weeded and the area is flat and has been cleared of all timber, ploughing and harrowing can be done at intervals.

Although generally not much success has been obtained with catch crops on land under permanent tree crops (*e.g.*, rubber and coconuts) in Malaya, Robusta coffee can be grown for three to four years, or pine-apples for the same period, in order to produce revenue to assist in the upkeep of the estate before the palms come into bearing After the palms come into bearing in the third to fourth year leaf pruning is usually carried out by removing the fronds below the bunches of fruit shortly before the fruit ripens. In no case should drastic pruning be adopted since this affects fruit production, and the palms are also liable to be attacked by beetles, resulting possibly in the death of the palm.

Male and female inflorescences (flowers) are borne by the same palm, but not necessarily at the same time, hence pollination of the female flowers is effected by pollen from the male flowers on other palms—*i. e.*, cross pollination takes place. The female flowers have been proved to be receptive for only two or three days, and only during this period can they be fertilised. Experience in the East has shown that natural pollination in the case of the young palms often fails, and this has led to experiments on artificial pollination by hand. The pollen is collected from the male flowers by shaking these over a funnel which is held over a suitable receptacle (a cigarette tin will meet the case) into which the pollen falls. The pollen should be collected preferably in the afternoon and dusted on the receptive female flowers during the following morning. The ripe inflorescences are noted by the distinctive odour of aniseed which is emitted, while the colour and other characters of the female flowers also indicate their receptivity.

Up to the present the cultivated palms have not suffered much from attack by pests or fungoid diseases, but the risk will increase with the planting of large continguous areas, as in the case of most economic plants. The rhinoceros beetle and the red-stripe weevil, both of which are pests of the coconut palm, have also caused damage to oil palms. Rats, wild pigs, squirrels, and porcupines have also caused damage to the fruit of young palms. Fortunately, it has been found that the damage done to individual fruits has not affected the quality of the palm oil from such damaged fruit. Animals of this nature are destroyed by trapping and by means of poisoned baits.

COLLECTION OF CROPS.

The earliest stage at which the palms in Malaya have commenced to bear fruit is about three years after planting. The fruit, which is borne in

large bunches or "hands" ripens in about six months after pollination has been effected. The palms yield during the whole year although the maximum crop is obtained during the drier season and the maximum production per month is about double the average monthly production. This is a point of importance in connection with the factory operations involved in treating the fruit and extracting the oil.

The mature fruit bunches are cut and conveyed to collecting sheds in various parts of the estate, in which they are stored on racks for about three to four days to complete the ripening of immature fruit. The collecting sheds consist of long attap (palm) roofed sheds with open ends. Sloping racks constructed of bamboo or wood poles are placed along the sides of the shed to support the bunches of fruit, and the fruit as it ripens drops into trays placed beneath the racks. After three to four days all fruit which still adheres to the bunch is usually readily removed by hand after the bunches have been cut up. The fruit is then collected in large baskets and conveyed to the central factory for further treatment. On the one producting estate in Malaya at the present time a light Decauville rail track has been laid from different parts of the estate to the collecting sheds, and thence to the centra factory, to facilitate transport of the fruit. In no case should the fruit be stored in heaps, otherwise fermentation soon takes place, and the palm oil in the pericarp of the fruit is deteriorated by the splitting up of the oil into free fatty acids and glycerine due to a fat-splitting enzyme (ferment) present in the fruit and also possibly by the action of micro-organisms. This is the principal cause of the inferior palm oil prepared and exported from the West African colonies.

Experiments have also been carried out with machines for the mechanical separation of the fruits from the bunches at the central factory, but so far this has not been very effective owing to the bruising of the fruit and the consequent deterioration of the palm oil. By a preliminary immersion of the fruit bunches in boiling water before such treatment, it has been found that the deterioration does not occur. A disadvantage, however, of this process is that about half the weight of the bunches which is waste material has to be transported to the factory, and also larger vessels for the preliminary sterilisation of the bunches are necessary. On the other hand, labour is saved and collecting sheds are unnecessary.

The fruit consists of an oily fibrous pericarp or outer layer, containing a small nut with a hard shell, which again encloses a small hard oil kernel. The nut resembles somewhat a miniature coconut, but the kernel is nearly always solid and not hollow like the kernel of the coconut, and is also much harder than the flesh or meat of the coconut kernel.

The fruit in Malaya has the following average composition :—

Fruit	Pericarp 58 %	Palm oil	...	53 %
		Moisture ...	...	33 %
		Fibre and residue	...	14 %
Nut 42 %	Kernel 15 %	Palm kernel oil	...	43 %
	Shell 85 %	Moisture and residue		57 %

Palm oil in whole fruit	31%
Kernel in whole fruit	7 %

CROP YIELDS.

The number of bunches of fruit per palm per annum may vary from six to ten, and the weight of actual fruit per palm per annum may vary from about 50 lb. to 150 lb., according to the age of the palms. When the palms come into full bearing the yield of palm oil will amount to at least one ton per acre per annum, and the yield of kernels about a quarter ton per acre per annum. On one estate in Malaya at the present time, even with primitive methods of extraction, a yield of about three-quarters of a ton of palm oil per acre per annum is being obtained from palms about five to six years old. In figures of West African exports it will be seen that the weight of kernels exported is considerably higher than the weight of palm oil exported. This is probably due (1) to the wasteful native methods of extraction of the palm oil, and (2) to the local consumption of palm oil in the West African colonies.

It has been mentioned previously that the palm fruit contains two distinct oils—palm oil obtained from the pericarp of outer layers of the fruit surrounding the nut, and palm kernel oil obtained from the kernel. In the case of the indigenous palms in the West African colonies the native method of extraction of palm oil has been and is still of a very primitive character, resulting in the production of a very inferior oil. Scientific investigations have shown that the pericarp of the fruit contains a fat-splitting enzyme (ferment) which converts the oil into glycerine and free fatty acids. This results in (1) an inferior oil which is unsuitable for edible purposes; (2) loss of oil during extraction; (3) loss of a valuable by-product—glycerine. It has also been proved that by the collection of ripe fruit, prevention of bruising, and preliminary treatment of the fruit before the oil is expressed, an oil of very high quality, containing less than 3 per cent. of free fatty acids, can be obtained. West African oils frequently contain 50 per cent. or more of free fatty acids. In addition to the higher published market values of the palm oil, a premium of 1*s.* 9*d.* per unit of free fatty acids below 18 per cent. is paid on each ton of oil. Thus a premium of £1. 6*s.* 3*d.* (15 × 1*s.* 9*d.*) is obtained for an oil containing only 3 per cent. of free fatty acids.

EXTRACTION OF PALM OIL.

Until recently, even under plantation conditions, palm oil has been expressed from the fruits by somewhat primitive methods which, although producing an oil of high quality, have been inefficient, resulting in an extraction of only 19 per cent. of oil from fruit containing an average oil content of 31 per cent. The remaining oil is left in the pericarp and is wasted. Much attention and investigation has been devoted for some years to the design of suitable machinery for the expression of palm oil. It has been proved that the hydraulic presses which are used for most oil-bearing seeds—copra, groundnuts, &c.,—are unsuitable for palm fruit, and machinery of this type has been purchased and "scrapped" in several instances. The construction of suitable machinery appears now to have been accomplished by British efforts, and the principal difficulty in connection with the production of the crop under plantation conditions has therefore been solved. The machinery designed is also suitable for both small and large estates, and appears to be very efficient. The following is a brief description of the process of extraction of palm oil by modern methods.

The whole fruits, after separation from the bunches, as described previously, are placed in large cylindrical steamers or kettles and steam heated for about fifteen minutes at a pressure of about 3 lb. above atmospheric. This sterilises the fruit, renders the oil more fluid and liberates it partly from the pericarp. The hot fruit is then transferred to steam-heated centrifugal machines, similar to those used for extracting sugar from the concentrated cane juice in sugar factories. The oil is very efficiently separated from the fibrous pericarp and nuts in these machines and is conducted int

settling tanks, where the water from the condensed steam "foots" (finely suspended matter), and any dirt are separated. The oil floats on top of any water and can be drawn off through pipes into barrels or tins. The residual pericarp and nuts from the centrifugals are then passed through a horizontal cylindrical rotary dryer, which is heated by exhaust gases from the boiler used for steam-raising. (Note : In the case of fresh fruit on an estate it may be found necessary to dry this material in the sun or on hot floors for a short time before passing it through the rotary drier.)

By this treatment the almost oil-free fibre of the pericarp is nearly completely separated from the nuts, but is transferred to rotary sieves in which the complete separation is effected. The fibre is used as a fuel in the boilers, while the nuts are transferred to nut-cracking machines. The cracked shells and whole kernels are then transferred to a brine bath of suitable density, in which the shells sink and the kernels float. The kernels are skimmed off by means of wire baskets and are transferred to a centrifugal machine in which the adhering brine is removed completely and is returned to the bath. The shells in the bottom of the bath are removed by a suitable conveyor and also transferred to a centrifugal machine in which the adhering brine is recovered and returned to the bath. The kernels from the centrifugal are ready for bagging and shipment, while the shells are used as fuel in the boiler. By the use of suitable mechanical conveyors and elevators the whole operation is almost automatic and continuous, and only a small factory labour force is required.

The oil from palm kernels has hitherto always been expressed by the use of hydraulic presses of various types, similar to those used for other oil-seeds in Europe. The residual palm kernel cake, after most of the oil has been expressed from the kernels, is a valuable ingredient of cattle foods, and it is advisable therefore that the palm kernels be shipped direct to Europe or countries into which they have been imported hitherto rather than expressing the oil on the estate, which will involve the erection of additional expensive machinery.

Recent market quotations for oil palm products are as follows :—

Palm oil (Lagos)	...	£40	per ton.
Palm kernel	...	£20	,,
Palm kernel oil	...	£45	,,
Palm kernel cake	...	£7	,,

Malayan palm oil will fetch about 25s. above the usual highest market quotation for West African oils.

From the experience already gained from Malaya and Sumatra, it is considered that the cultivation of the oil palm will yield a useful return to the investor. From the market quotations given above a return of between £40 and £45 per acre should be obtained, which is nearly twice the amount obtained per acre from coconuts. Additional capital cost of machinery is required, however, in the case of oil palm cultivation. This should not amount, however, to more than £10,000 for a 2,000 acre estate or, say, £5 per acre. The cost of bringing oil palms into bearing should not be as great as in the case of coconuts, and should not amount to more than £40 per acre inclusive of machinery. In the above return no account has been taken of factory costs of manufacture of palm oil, but even when allowance is made for this the gross profits per acre should be considerable, and, if the price of vegetable oils remains steady, as appears highly probable, a return of 20 per cent. on the capital expenditure should be easily obtained.—The Manchester Guardian Commercial, Feb. 19, 1925.

AGRICULTURAL RESEARCH.

THE OPENING OF THE NEW CHEMICAL LABORATORY AT PERADENIYA.

The new Chemical Laboratory of the Department of Agriculture was declared open by His Excellency the Governor, in the presence of the members of the Board of Agriculture, on March 12th, 1925.

The Director of Agriculture, in asking His Excellency to declare the Laboratory open, said :

Your Excellency,

Towards the end of 1922 you visited Peradeniya to open the Entomological and Mycological Laboratories and in asking you to declare these Laboratories open I expressed the hope that it would be possible to find funds at an early date for the establishment and equipment of an urgently required research laboratory for Agricultural Chemistry. The Legislative Council has been convinced of the necessity for this provision and to-day at this meeting of the Board of Agriculture, which will be the last over which Your Excellency will preside, it is my privilege to ask you to declare the recently erected Chemical Laboratory open.

During the period of your administration in this Colony you have taken an active part in strengthening the Department of Agriculture as you recognised from the beginning the necessity for adequate provision for scientific assistance to the agricultural industries. Tropical agriculture is in need of scientific research. The problems which require solution are many and without suitable provision for work solid progress cannot be expected. Laboratories were first erected for those branches of the Department dealing with Plant Pests and Diseases and now another laboratory has been completed for Agricultural Chemistry in which it is intended to make special investigations in regard to the soils of Ceylon and their manurial requirements.

On this occasion, I cannot but voice the feelings of regret of the whole agricultural country of Ceylon in not having in our midst Mr. Kelway Bamber. His sad death as the result of a motor accident whilst in England has left a void in our midst which cannot be filled. Mr. Bamber came to Ceylon in 1898 after some years at a Government Research Institute at Muktasar in Northern India and as Chemist to the Indian Tea Association and ultimately opened a laboratory in Colombo as an Analytical Chemist. From 1900 he was retained by Government as consulting Agricultural Chemist and from that date his knowledge and experience was whole-heartedly placed at the disposal of the Government and of the agricultural industries of the Colony. In the establishment of this new Laboratory, I received material assistance from him and I hope that it will be possible to raise a memorial to his name within the Laboratory now to be opened. Mr. Bamber's work on green manuring, upon tea and rubber, and also in connection with other industries, is well known in Ceylon and all of us in the Department of Agriculture know that we have lost a never-to-be-forgotten friend.

In this Laboratory, accommodation has been provided as in the other laboratories for post-graduate students and it is hoped that before long it may be possible for graduates from the University of Colombo to receive special post-graduate training in Agricultural Chemistry.

The progress of Agricultural Chemistry in recent years has been remarkable and the complexity of many agricultural problems has been established. These can only be solved by continued patient research. The number of problems in Ceylon is a large one, but I feel certain that the work of this laboratory will assist in the solution of some of them.

Mr. A. W. R. Joachim, a Ceylon Scholar who has taken a full specialized course in agricultural chemistry and soil science at the University of Cambridge, has been selected by the Secretary of State for the post of Agricultural Chemist and will take up duties in this connexion with effect from April 1st His first work will be in connexion with Ceylon soils and with manuring problems. I hope that results of value and importance to the Agricultural Industries will be shortly forthcoming.

The building has been completed by the Kandy branch of Public Works Department and I desire to place on record my appreciation of the efforts of Mr. E H. Van der Straaten and Messrs. Kirby and Scott, District Engineers, for their willing co-operation.

I have, Sir, great pleasure in asking you to declare open this laboratory, but before doing so I wish to thank you on behalf of the Board of Agriculture for the very great interest you have at all times taken in matters affecting the welfare of agricultural industries of the Island and to ask the Hon. Mr. T. Y. Wright and the Hon. Sir H. M. Fernando to supplement my brief remarks.

COL. WRIGHT'S SPEECH.

Col. Wright speaking in support said: I have been asked to say a few words on this occasion. The Director of Agriculture has very rightly told us that tropical agriculture is greatly in need of scientific research and Planters' Associations recognize the fact. During your term of office, Sir, Rubber Research Scheme has come into being and no one can blame you, Sir, that both Tea Research Scheme and Coconut Research Scheme have not come into being as well. We know full well that Your Excellency would have helped us in every possible way in our endeavours to get these schemes working and I have no doubt that they will come into being before long, but it would have been much nicer if all had been started during Your Excellency's term in Ceylon. These laboratories, one of which Your Excellency has declared open to-day, are undoubtedly needed not only for tea and rubber but also for the benefit of food production of the island. Your Excellency will I know be delighted, as we all, are that a young Ceylonese has been appointed to the post of Agricultural Chemist. It is a step in the right direction and I would like to take this opportunity of congratulating him. We planters very greatly appreciate the interest Your Excellency has taken in agriculture during your term of office in Ceylon.

SIR MARCUS FERNANDO'S SPEECH.

Sir Marcus Fernando said: Your Excellency,

We are assembled here for the opening of the new Chemical Laboratory, a very interesting and important occasion. The laboratory will be

devoted to the application of Chemical Science to elucidate the problems of agriculture. This, as the Director of Agriculture has pointed out, is one of a series of laboratories which have been built in recent years and it will be of the greatest importance to the work of the Agricultural Department. Moreover, they will be of still greater importance when the Ceylon University embraces within its folds the wider activities and start a faculty of agriculture. Although this is the third of the series of laboratories opened in your regimé, I venture to think that it is by no means the least. Work in Entomology, work in Mycology were urgent, but work in Agricultural Chemistry is by no means the least important of the three. The Director of Agriculture has pointed out that during recent years great advances have been made in connection with the Science of Agricultural Chemistry. For the application of those advances to local problems of agriculture it is very essential that there should be laboratories like those fully equipped and under the guidance and direction of trained experts. Ceylon can no longer go on muddling its way simply on empirical methods. We cannot afford to do that because during recent years in the domain of tropical agriculture we find that we are faced with competition both in the East and the West. The Malay States, Java, the Philippines and in Trinidad there are highly equipped laboratories and fully equipped Agricultural Departments. Therefore it is necessary and essential that if Ceylon is going to maintain its position in tropical agriculture it should be fully armed with the weapons that science can give it. This is merely a general consideration pointing to the importance of the work that this Laboratory will have to do but we have also certain local problems which are always with us. Industries connected with tea, rubber and coconut spend annually, I find, an enormous sum in buying artificial fertilisers. Last year's Customs returns show that we had imported something like Rs. 9,700,000 worth of artificial manures. I don't contend that this money is thrown away. Our practical planters undoubtedly get full value for them—perhaps a little more—but the problem is this: Are we getting adequate value for this expenditure? Can we not get larger benefit perhaps by spending less by applying other methods in cultivation of the soil. Now, this is one of the problems which this institution will have to solve in the near future. We are assembled here again on this occasion with some regret because we find that this is the last occasion we of the Agricultural Board will see you as our President. During the term of your regimè we have appreciated fully how well you have fulfilled the promises which you made on undertaking the Government of this country when you said that the advancement of agriculture will be one of the chief features of your policy. During these six years you have done a great deal. I don't want to give merely a list of the work that you have done in advancing agriculture in this Colony because the list is a long one and is well known to most of us here. I should like to state one fact—a concrete fact which bears eloquent tribute to the manner in which you have kept your promise. In 1918-19 you allocated to the Agricultural Department a little over 2½ lakhs. This year I find you have allocated something like 8⅓ lakhs—a three-fold increase in six years. I don't intend to state any more on this occasion. On behalf of the Agricultural Board, on behalf of the masses of the people of this country, I offer you our grateful thanks for the great work you have done in connection

with agriculture. The other day in one of your utterances you mentioned that you cherished the hope in the near future to return to this Island on a visit. When that hope is realised I shall assure you that you will receive a very hearty welcome from the grateful people of this country.

HIS EXCELLENCY'S REPLY.

His Excellency the Governor, in declaring open the Chemical Laboratory, said :—

Mr. Stockdale and members of the Agricultural Board of Ceylon, I must first thank Mr. Wright and Sir Marcus Fernando for their very kind remarks referring to me. In Mr. Stockdale's remarks you will see that he mentions my first visit, or rather my visit in 1922, when I opened two Laboratories that were built that year. If you will carry your minds back you will remember that on that occasion, I said that the value and importance of the great industries in Ceylon demanded that the Government of this country should do all that it could to prevent and avoid such a disaster as overwhelmed the chief industry of this country many years ago. I said then, and say so again to-day, that I believe that if we had had on that occasion such an equipped Agricultural Department as we have to-day, that disaster might have been avoided. But in all these things possibly, I should say, the hand of Providence moves.

I think you are more fortunate to-day, in that you have a great tea industry rather than a great coffee industry. To put it into simpler terms, I believe tea pays you better than coffee would have. We are, may I say, still on the threshold of what I hope may be the work of this Department. We are endeavouring, and we shall continue patiently to endeavour, to discover the remedy for all these ills and misfortunes which the great crops of this country are liable to. We have in the medical world our general practitioners who deal with common ailments of mankind, but there are certain ailments which require the specialist. As the general practitioner we would take the planter in this country who knows generally when something is wrong with his crop. He knows there are some conditions which are affecting his crop which he himself can very easily put to right, but when there appears, as appeared years ago in the great coffee days, a very very serious disaster which unless he is able to bring before the specialist and unless he is able to consult the specialist may end, as did in the days gone by in complete destruction of the crop on which his livelihood depends and on which the welfare of the country in which he lives depends. Therefore it is these Laboratories presided over by scientists at their head who are in a way specialists who will be able to deal, as I trust they will be able to deal successfully, with these greater disorders which threaten the very prosperity of the great industries of this Island. Therefore naturally I and you and the head of the Department are only too anxious that these Laboratories should be well equipped, that they shall have fully trained staffs to deal with all those important questions which I know must come up from time to time.

GOVERNMENT'S FIRST ENDEAVOUR.

As Sir Marcus Fernando has said this is my last appearance at a meeting of the Board of Agriculture. Sir Marcus Fernando and Col. Wright made very kind remarks in connection with what I promised and what I have

carried out as regards the Agricultural Department. I have recognized and I still recognize to day that every Governor of Ceylon, which is an Agricultural country, must of necessity give his first endeavour and give his very first thoughts to work connected with the great industries in this country, the great and important industries without which this country would not be what it is.

During the few years that I have been here I have endeavoured humbly to carry out the promises that I made, and I have been most ably helped by the head of the Department here. He is a Government Servant upon whom I place the greatest reliance. I have always been to him year by year and said to him "have you got all that you want?" There are occasions when he has often said to me that he could do with more if I could find the men.

You will remember that when questions have been raised in the past as to why Government has not done more for the Agricultural Department, I have been able to give the reply that Government has only been too ready to supply funds for the development of the Department, but that unfortunately in those days after the war when scientifically trained officers were difficult to obtain the Department had not been able to obtain the scientists which it desired. Though I myself have been most anxious to move on, there have been occasions when I had to hold my hand because we could not obtain that staff that was necessary for the proper working of the Agricultural Department. Still, I honestly say that I have endeavoured to do all I could to ensure, as I trust is the case now, that this Department should be properly staffed and that its buildings, Laboratories and scientific work should be of the very best, and that its work should be carried out in the most thorough manner possible.

RUBBER RESEARCH SCHEME.

Col. Wright has mentioned a subject concerning which I am very considerably interested. It was during my term of Office that the Rubber Research Scheme came into being. I enquired last night from the Director of Agriculture whether he could say that those who have liberally supported the Scheme could state that they had received full value from the Scheme. He satisfied me that such was the case and that a great deal had been done during the last five years as to enable the Planter to undertake work which he could not do before on his estate, and enable him, when he found that there were matters beyond his scope, to refer those matters to the Department and get sound and useful advice. I do hope with Col. Wright, in fact I feel sure that in the coming year or the year after there will be established a Tea Research Scheme and a Coconut Research Scheme. I feel sure that the same benefits which the rubber industry has received from the Rubber Research Scheme will also be forthcoming for the tea and coconut industries. Should that be so I shall feel that at any rate the major industries of this Island are receiving their proper attention and the care which they rightly deserve.

SOIL ANALYSIS.

Sir Marcus has mentioned the great importance of this Chemical Laboratory and he has spoken scientifically in connection with the matter. He tells you what I should have told you myself that there are still in the

soils of Ceylon as in every other land properties and deficiencies which the soil Chemist alone can discover. It is wonderful to me that Ceylon has gone on so well as it has during all these years when the properties of the soil have not been thoroughly well recognized. The deficiencies of soil, which could be made up with proper manurial processes, have not yet received full attention which I trust they are now going to receive. I believe this Laboratory will have a great effect in the years to come upon the crops of this country, upon their yields and also upon the disorders which many plants are subject to owing to certain soil deficiencies which when discovered Chemically can be put to right by proper manurial processes.

OBITUARY.

I have to deplore the deaths of Mr. J. Graeme Sinclair, Mr. Kelway Bamber, Mr. A. W. Beven and Mr. H. W. Gavin. I deeply deplore the loss of Mr. Graeme Sinclair. I deplore his loss as a personal friend. I deplore his loss as a great planter. I deplore his loss as a very popular member of Society. He was a man who gave his time ungrudgingly not only for the benefit of the planting community, but also for the help of us all and the help of his country, in the Legislative Council and generally as a sportsman and a real good fellow. Mr. Kelway Bamber you know better possibly than I do. You know how deeply he was interested in agricultural problems here. You know his great scientific attainments. You know what a standby he was in all matters in connection with manurial questions in this country. You know what he did during his term of office here. As the Director of Agriculture says his death is a very great loss and he was one whose place it will be very difficult to fill. Of the other gentlemen I mentioned, I have not had close acquaintance with them, but their loss is also a loss to this Board. We who are here to-day do wish that they may rest in peace.

A CHAIR OF AGRICULTURE.

Another point which has been brought out is one which naturally must very greatly interest me. It is that in these Laboratories it will be possible for graduates of the Ceylon University of the future to take their post-graduate training courses in Agriculture in connection with the University of Ceylon. This has been from its very inception very near to my heart. We have always felt that in addition to the courses in the usual arts subject there must be a faculty, as Sir Marcus has said, a faculty of Agriculture, which It rust will be one of the leading faculties in the University. The University will have its teachers, its technical professors and the graduates who will take up, as I trust many will, a course of agriculture in this University will find here in these buildings that very training which will fit them for actual work upon the estates in Ceylon. They will be able to learn and I trust they will be able to imbibe that knowledge, which, when they go out either as planters or Superintendents of estates, they will be able to apply with such success that the Ceylon University student who has taken a post-graduate course in this Laboratory will be eagerly sought after as scientifically trained in every industry, tea, rubber, or coconuts, and his value will be recognized by the fact that he has had his training in this institution here.

One hope which I expressed a good many years ago was that the Ceylonese student, as Col. Wright has said, should be able to take his

place in the Agricultural Department as a fully trained man. We have here that ideal in Mr. Joachim who is going to be placed in charge of this Laboratory and who is fully trained and has received Diploma in Agriculture. He has come here as an Agricultural Chemist to take charge of this Department. I trust that this will be to all Ceylonese students an incentive to follow in his footsteps.

There are openings—I have been criticised in the past, I don't mind criticism, and I say it again to-day—there are openings in the planting industries of this country for the Ceylonese if they would seize with both hands the opportunities that are being presented to them in these Laboratories, opportunities, which I trust, will later on be presented to them in the Ceylon University.

THE STAFF

I must in conclusion say a few passing words in connection with the staff of this Department. I feel sure that you will re-echo my remarks. I have had experience of Agricultural Departments in other Colonies. I have had experience where there has been rub and friction between the Agricultural Department and the planters of that Colony. On one occasion, I will not mention where, in the earliest days of my Governorship there was demand that there should be a Commission of Enquiry into the working of the Agricultural Department. That Commission sat for a long time, but the result of the inquiry was not of great value to the Colony. There were reasons possibly for that friction. I say now as I said then that friction between the leading Department of the Colony and the planters of the Colony cannot possibly make for the good and the welfare of the industries of that Colony.

CO-OPERATION.

It is my very pleasurable task to be able to say to-day that I have watched and recognized during these years that there is no such friction in Ceylon. On the contrary, there is a desire that there shall be co-operation between the Department and planters. There is a desire that the most pleasant and cordial relations shall exist. I honestly say and believe that the co-operation and those pleasant cordial relations have done more in the last six-and-half years that I have been here towards smoothing out difficulties which are bound to occur towards the betterment towards the advancement of agricultural science and towards the advancement of planting than you yourselves possibly recognize. I had asked, you will remember, some two-and-half years ago that planters would give to the Department that co-operation and support which I feel was so desirable if the work of the Department was to be efficiently and properly carried out.

I have to thank you, gentlemen, to-day for that co-operation and support you have so willingly given. I feel that the Director himself will agree that the Department has to thank you for all that you have done in making his way smooth and for endeavouring to support what he puts forward in the same way, as you, I feel sure, will thank him for all he has done.

After declaring the building open, there was an inspection of the same and subsequently an inspection of the work of the Entomological and Mycological Laboratories previous to proceeding to the Experiment station, Peradeniya, for the annual inspection of the work of that station.

SOILS AND MANURES.

THE UTILISATION OF SEEDLINGS IN THE ESTIMATION OF SOIL NUTRIENTS.

H. NEUBAUER,
Agricultural Experiment Station, Dresden.

The farmer has learnt how the yield of his cultivated areas can be increased annually by unremitting toil, attention and capability, better methods of tillage, use of improved seed, the prevention of plant diseases, and above all by the liberal application of fertilisers. The farmer used to follow the approved advice of Paul Wagner (Darmstadt) and gave his fields only a limited amount of nitrogen, which was expensive, and cannot be retained by the soil, while he applied an excess of potassium and phosphoric acid, without considering whether the repeated manuring with these fertilisers had not satisfied the potassic and phosphoric requirements of the soil to the extent of rendering it advisable to diminish the amount employed. This carelessness was due to the fact that the potassium and phosphoric acid were cheap and easily obtained. Those days are now past, and the universal economic depression has extended to agriculture, so that the farmer can no longer indulge in the luxury of wastefulness, but is obliged to exercise the strictest economy not only in the management of his capital above ground, but also in the use of the valuable stock of plant nutriment that lies hidden in the soil. To employ this treasure aright necessitates a thorough knowledge of its character and value, but unfortunately the agriculturist is still ignorant of its nature and importance in spite of all the efforts of science and of the practical investigations that have been carried out.

Hitherto, three methods have been employed for determining the nutritive substances present in the soil: pure chemical analysis, manurial field experiments and vegetative experiments with plants in pots. All these methods have proved inadequate for the purpose. Chemical analysis is in the first place far too rough a test, for the soil chemist can only analyse correctly up to a hundredths per cent., his results being inaccurate for thousandths per cent. Since, however, the soil over 1 hectare of surface taken to the depth of the plough furrow weighs about 3 million kilograms, one thousandth per cent. is 30 kg., and an error of five thousandths per cent., a mistake easily made, would give 150 kg. which is far too high a figure. Chemical analysis is also unreliable for another reason; the chemist can determine without difficulty the total amount of any nutritive substance contained in the soil, but he is unable to state how much of it can be taken up by the roots and assimilated by plants, which is the important point. No certain results have hitherto been obtained from the chemical soil analyses made for the purpose of ascertaining how much nutritive matter the weak efforts of plants have succeeded in wresting from the soil. If any chemist were to affirm to the contrary, he would probably not find a single practical

agriculturist ready to believe him, for unwavering confidence in the case of such predictions is more difficult than under any other circumstances, because the store of nutritive substances present in soil is not the only growth factor. The crop-yield depends upon other conditions, especially upon the weather, therefore even if the estimate of the amount of nutritive substances in the soil were correct, there would not infrequently occur a discrepancy between it and the harvest, and it would need great faith on the part of the practical agriculturist to realise that the difference in the theoretical and the calculated values, was not to be attributed to the mistake of the soil-analyst.

Therefore let us dispense with all chemical methods. Plants alone are able to give a reliable answer to our questions. Field manurial experiments and pot-cultures are the only forms in which the problem has hitherto been applied to plants, and such methods will always be valuable for soil investigation and throw light upon the subject of plant nutrition, but unfortunately, they are troublesome and lengthy. Any one who has conducted manurial experiments in the field is well aware of the difficulties they present. Very often these experiments are interfered with by the weather, so that accurate results are only obtained if the researches are extended over several years. Pot-culture experiments are less dependent upon weather and have reached a high stage of perfection, but they require an extensive and special equipment which few Institutions possess and could now only be purchased with difficulty owing to the high cost of material. Further, pot experiments are very long and troublesome and hence expensive; therefore, it is quite impossible for agriculturists to obtain by this means, and within reasonable time, any general information respecting the nutritive substances content of their cultivated soil. Hence there is urgent need of a method of mass experiment, by which any Experiment Station can carry out, without new, costly apparatus, hundreds and even thousands of soil sample analyses, to determine the nutritive substances present in them which can be assimilated by plants. Farmers should be given the opportunity of forwarding samples of their soil at all seasons, in summer as well as in winter and these samples must be quickly, cheaply and accurately investigated, just as fertilisers and stock-feeds are tested. In this way, it will be possible, not only for the few favoured individuals who are in a position to conduct plant experiments, but also for the great mass of agriculturists, to suit the fertilisers applied to the requirments of their various soils and thus to farm systematically, a result that is of paramount importance, both from the point of view of nation economy and the nation's food supply.

The principle upon which is based the carefully worked-out method* devised by myself and my colleague Dr. Wilh. Schneider (Bonn), is the hitherto unknown fact that young seedlings do not live as long as possible upon the reserve materials of the seed, but employ their rootlets, as soon as they are developed, to obtain nutritive substances from the soil.

If a large number of young seedlings are planted in a small quantity of soil, the starving rootlets extract all the assimilable nutritive substances their strength permits, but leave untouched the non-assimilable matter. In

* "Die Nahrstoffaufnehme der Keimpflanzen und ihre Anwendung auf die Bestimmung der Nahrstoffgehalts der Boden". *Zeitschrift für Pflanzenernährung und Düngung*, Part A 2, Year 1923, No. 5, Leipzig.

this manner, the plant rootlets separate out the soluble from the unsoluble substances, thus rendering a valuable service also to the chemist, since their choice is certain and leaves no room for doubt.

Our experiments were conducted as follows:—Upon the level bottom of some small glass dishes measuring about 100 sq. cm. at the base and 6 cm. high, were spread 100 gm. of the soil to be tested, mixed with 50 gm. of pure quartz-sand, the so-called "glass-sand," which is free from any nutritive substances. Over this was laid 250 gm. of damp glass-sand, and upon the smooth surface were planted 100 seeds of the best, heavy, seed-rye. The seedlings soon germinated; they were carefully tended, and removed with their rootlets after 17 to 18 days and analysed. Only part of the mineral substances entering into the composition of the seedlings thus came from the soils to be tested, for a considerable amount was derived from the reserve stores of the seed. For this reason, we also carried out a blank experiment on barren sand to which no soil had been added and substracted the nutritive substances found from the total before obtained. The remainder was clearly derived from the soil.

So far, we have only used this method for the determination of potassium and of phosphoric acid, but we are convinced that it could also be employed in the case of other nutritive substances, such as nitrogen, for instance. The amount of phosphorus yielded up in this manner to young rye-seedlings by 100 gm. of soil, ranges, according to observations made, from 5 to 100 mg., while the phosphoric acid varies from 0 to 25 mg. Since 1 mg. per 100 gm. of soil is equivalent on an average to 30 kg. per hectare, the young seedlings on 1 hectare of soil abstract from the soil up to 3,000 kg. of potash and up to 750 kg. of phosphoric acid in 18 days. These amounts appear very large at first sight, but in reality they are very small. The seedlings used in the experiment were starving, which was necessary, otherwise they would not have exhausted the soil, but plants under natural conditions take up a much larger amount of nutritive substances in the same short space of time. The reason that they do not exhaust the soil to an equal extent is simply that our cropping plants naturally have a thousand times as much soil at their disposal. Parallel determinations made according to the new method agree as exactly as chemical analyses, provided they have been executed by skilful and trained persons.

As can be seen from this brief description, the new method not only has the advantage of being quickly carried out by means of small packets of soil samples that can easily be forwarded by post, but it also has another point in its favour. Whereas in other vegetation experiments it is necessary to insure the optimum condition of the growth factors that are not involved in the test, and to supply an excess of all the nutritive substances not under consideration, in this new method all that is required is water and warmth. Especially good illumination is not even essential. In this manner, the carrying out of the experiment is greatly simplified, there is no danger of producing unwelcome changes in the soil by the addition of other matters and it is thus possible to use the same material for the determination of the root-solubility of many nutritive substances instead of being necessary, as hitherto, to fit up the experiment anew for each fresh

compound. In the usual type of vegetation experiment, the amount of nutritive substances contained by the soil is estimated from the yield of plant substances when the plants are gathered. Therefore the nutritive substances in question must not only have been taken up by the plants, but also turned to excellent account, which according to the "law of minimum," or as it is now called the "law of the influence of growth factors," is only possible when all the growth factors not involved in the test are at their optimum. By this method, however, there is no need to ascertain what the plants do with the nutritive substances they have absorbed from the soil, it is sufficient to ascertain the amount they have abstracted. Fortunately, the law of the influence of growth factors, which is so troublesome in other experiments, does not appear to affect the mere abstraction of nutritive soil substances by very young seedlings that still possess a large store of reserve material. We may imagine the plants saying, "let us diligently collect only stones for building and we shall soon find means of using them." In the open fields also, the first efforts of the germinating seed in early spring, are directed to collecting building material to be used later, when the chlorophyll apparatus has become strong, under the influence of more intense irradiation.

From what has already been said, it is clear that a much larger number of tests can be made by the new method of vegetation experiments than was possible to carry out with the old systems; further, the experiments can be conducted at all seasons of the year. One important question, however, remains to be answered, *viz.*, is the new method accurate and trustworthy? That it is based upon existing laws has been shown by the agreement of parallel experiments and the great differences in the data obtained in the case of soils of unlike composition. How far this method is practically feasible must be decided by comparing the results obtained with those found by means of field manurial experiments, but as these are themselves affected by several sources of error, it is advisable to take the soil samples from experiment fields that have been long under observation. This has in fact been done, and I have always requested my colleagues when forwarding such samples, not to give me any information respecting the nature of the soil and its condition as regards fertilisers, until I have reported the findings of my experiments and made my calculations. They invariably complied with my wishes, with the result that will presently be given.

In order to determine by the seedling-method the nutritive substances required by a soil, it is needful to know how many mg. of each nutritive substance must be contained by an amount of the said soil, corresponding to 100 gm. of dry substance.

Judging from our present experience, we are of opinion that the *highest* yields can only be obtained from the plants in question (in the absence of potassic or phosphatic fertilisers), when it is possible for the seedlings to abstract, from a quantity of soil corresponding to 100 gm. dry substance, the following minimum amounts:

	Potassium mg.	Phosphoric acid mg.
Rye, Wheat	14	8
Barley, Oats	18	7
Red Clover	29	9
Lucerne	34	13
Meadow plants	38	10
Potatos	37	10
Sugar-beets	39	12
Mangels	60	14

It is necessary to remark that these limits are based upon a general estimate and must be supported by the evidence of further experiment.

They apply to arable soil of the medium depth of 25 cm., where no nutritive substances have been added to the subsoil. It is of paramount importance that the amounts of nutritive substances supplied are enough to produce a maximum yield. Should it be impossible to obtain a maximum crop owing to the mechanical composition of the soil tested, or to the climate or lack of water, smaller quantities of nutritive substances that can be assimilated by plant roots will be sufficient. Therefore the data obtained from the seedling-method cannot be used as a general scheme. This objection applies not only to our method, but also to all other artificial systems. Field manurial experiments are indeed free from this limitation, but they have many other drawbacks.

The testing of our new method by the investigation of soil samples from experiment fields of known condition as regards fertilisers, included 65 potassium and phosphoric acid determinations. Most of the data are given in the above-mentioned treatise and as space is lacking here to reproduce the tables, it is only necessary to state that the agreement between the figures found and the condition of the fertilised fields, was in every case very satisfactory.

The following facts have not hitherto been published. The figures represent the amounts (in mg.) of potassium and phosphoric acid found by means of the seedling method in a quantity of soil corresponding to 100 gm. of dry substance. The experiments were conducted in the experiment field of the University of Halls (Saale). This field had been planted with rye uninterruptedly since 1879; it was manured annually with stable manure and also with chemical fertilisers.

Kind of Fertiliser.	Potassium.	Phosphoric acid.
Unmanured - - -	9·9	5·1
Nitrogen alone - -	7·2	3·5
8,000 kg. stable-manure -	18·0	6·8
12,000 kg. ,, - -	22·2	8·3
Complete mineral fertiliser without nitrogen - - -	35·0	15·0
Complete mineral fertiliser -	30·6	16·7

The figures agree very closely with the actual conditions.

EXPERIMENTAL FIELD OF GOTTINGEN UNIVERSITY.

The field had been planted with regular rotations of crops for 30 years and manured during that time as follows. No lack of potassium was noticeable (except, in the case of very exacting plants), even on the plots that had received no fertiliser.

Kind of Fertiliser Used.	Potassium.	Phosphoric acid.
Unmanured - -	29·1	19·7
Nitrogen only - -	21·7	14·8
Phosphoric acid only - -	26·2	25·1
Potassium only - -	56·0	19·5
Complete fertiliser without potassium -	25·5	17·4
Complete fertiliser without phosphoric acid - -	57·5	19·3
Complete fertiliser without nitrogen -	61·9	22·0
Complete fertiliser - -	59·4	21·4

Here again the experimental results were a true reflection of the soil conditions as regards manuring.

Experiment Station of the Agricultural College ("Landwirtschaftliche Hochschule") of Bonn-Poppelsdorf, Bonn.

The experiments have been in progress since 1896. No lack of phosphoric acid has been shown even on the unfertilised plots. On the plots without potassium, the yield was little decreased in the case of wheat, but was much lower than usual in some instances where the crops were of a more exacting character. The fertilisers were not heavily spread as in the case of the Gottingen experiments but the amounts given were calculated to replace, as far as possible, the substances abstracted by the crops.

Kind of Fertiliser.	Potassium	Phosphoric acid.
Complete fertiliser without nitrogen -	24·5	15·8
Complete fertiliser without potassium -	14·8	14·9
Complete fertiliser without phosphoric acid	25·6	9·0
Complete fertiliser - -	22·3	11·3

The figures found gave a very accurate conception of the condition of the field as regards fertilisers.

Soil composed of weathered Bunter sandstone: field manurial experiment with winter-barley; previous crop five-year lucerne. The figures obtained were: potassium 54·6 m g., phosphoric acid only 4·0 mg., therefore the soil must be regarded as very rich in potassium, but poor in phosphoric acid. The field manurial experiments gave the following results:—

Unmanured - -	2,950 kg. grain
Manured with nitrogen and potassium	3,090 ,, ,,
Manured with nitrogen, potassium and phosphoric acid -	4,720 ,, ,,

Here again, the manurial condition as shown by the behaviour of the young seedling method was fully confirmed by the field manurial experiments.

The new method will be further extended with a view to the determination of the lowest values that will provide the amount of nutritive substances necessary to completely satisfy the requirements of different plants under various conditions of soil and climate, even in the case of a maximum yield. Whether rye is the best plant to use in these researches, will also be investigated, and whether it is sufficient to keep to a single variety of plant throughout the experiment.

The success already attained inspires us with the hope that this new method will be adopted in all Agricultural Experiment Stations as being a valuable aid to research, and useful in giving every farmer the opportunity of obtaining a clear idea of the store of nutritive substances present in his soils. It is hoped also that the scope of the new method will be further extended, for we believe it will prove of great service and enable us to penetrate quicker and deeper than heretofore into many of the domains of soil science and of plant physiology.—International Review of the Science and Practice of Agriculture, Vol. II, No. 4.

SOIL MANAGEMENT PROBLEMS.

PROFESSOR J. SYDNEY DASH, B. S. A.

Although our knowledge concerning soil fertility has undergone considerable change since the days of Van Helmont and his willow tree experiment, Tull and others, it is only during the last hundred years that the more fundamental contributions to the study of soil science and plant nutrition have been made; in this connection, such names as de Saussure,

Liebig, Hellriegel, Lawes, Gilbert, Cameron, Whitney, Hall and Russell—to mention only a few representing various schools of thought up to the present day—should be familiar to everyone. During the period previous to 1804, nitre, water, air, fire and earth had at various times been regarded as agents in the nourishment of plants. Readers may be reminded particularly of the conceptions of Tull who taught 200 years ago that soil particles constituted the real food of plants and that if these were made fine enough by cultivation, the plants could then absorb these fine particles and produce crops continuously. With the discovery that the food of plants was both mineral and gaseous, the former from the soil and the latter from the air, the belief soon grew as a result of chemical and mathematical considerations that soils would eventually become exhausted from cropping unless provided with new sources of plant food. Thus, the developments arising from the investigations of Lawes and Gilbert on the problem of providing readily available substances to be added to soils in order to satisfy crop demands, and which paved the way for the extensive use of commercial fertilizers, further emphasized the view among chemists and agriculturists that all that was necessary was to feed the plant.

Up to this point, the plant itself had received little attention ; it is now recognized, however, owing largely to the researches of the geneticist, agronomist and physiologist, that soil, plant and climate must all be reckoned with as factors in crop production. This does not mean that the chemical aspect of soil treatment has lost in importance ; to mention only one recent investigation bearing on this question, in Hawaii studies on potash requirements of cane soils indicate that those containing more than ·03 per cent. of potassium oxide soluble in one per cent. citric acid will not give profitable returns from potash applications. On the other hand, it is certain that no one branch of agricultural science can claim a monopoly in what concerns the all-important question of raising crops plentifully and profitably. Indeed the more closely it is studied the more complicated the problem seems to become, and in the final stages the agricultural engineer may play not the least part.

As a result of field and laboratory investigations up to the present time, there emerges the general fact that the tiller of the soil need no longer be unduly worried over the probability of soil exhaustion to a point where it will cease to produce; rather, he should be concerned with maintaining fertility at a standard which will allow of crops being grown at maximum profits and minimum expense compatible with the requirements of permanent agriculture. In this connection what causes the greatest possible concern—and for which adequate remedies are not yet forthcoming—is the heavy soil losses, apart from crop demands, to which good agriculturists are subjected year in and year out. To suppose that because a careful planter, by sound methods of management, puts into his soil much more food materials than his crop needs must expect to lose that which is not wanted, is equivalent to supposing that because a millionaire banks much more money than is necessary for his needs, the surplus should be lost. Awaiting a satisfactory solution of this problem, the good agriculturist in order to keep fertility up to the standard already indicated, must not relinquish his efforts in respect to

tillage, manures, amendments, rotations and the like, and the use of every possible means to prevent erosion and soil wash—both responsible for heavy losses under tropical conditions.

Dealing first with tillage, we are reminded forcibly of Tull's theory mentioned earlier and its corollary—tillage is manure. It is true to-day in the sense that tilling the soil helps to make potential plant food available and also provides better environmental conditions for plant growth. It is an aspect of soil management which is assuming increasing importance and must continue to do so in proportion as populations increase, sources of fertilizers become more and more exhausted, and with the growing recognition that crops need other things beside food. Slowly but surely these facts must reach the tropical planter who has hitherto depended too much on the natural conditions of soil and climate; he should understand that perfection of factory and technological methods in the preparation of his produce mean little or nothing in the long run if the fields are not producing the raw material, and further, it is a sound economic law that improvements in one direction invariably call for improvements in another. Thus, the agricultural engineer in the handling and development of power and implements for efficient tillage, cultivation, irrigation, &c., with a view to increasing production and lessening costs is equally as necessary as the factory engineer. Moreover, tropical soils by virtue of their often compact and heavy nature demand that greater attention be paid to tillage and such practices which improve texture and tilth rather than the mere application of fertilizers.

Of all the manures at the disposal of the agriculturist, farm manure is the most important; unfortunately, in many parts of the tropics labour, cost of making and applying is given as a reason for its limited use. Judged as a supplier of plant food only, this attitude is probably the correct one; as a tilth improver, however, there is scarcely anything to equal it. Measurements at Rothamsted have shown a saving of over 22 per cent. on the power consumption required for ploughing dunged as compared with undunged soil; added to this is the gain in moisture content of the soil as a result of dunging, 5 per cent. and even more being reported—an important consideration where droughty conditions have to be faced. Its influence on the microflora of the soil should also not be lost sight of. Balancing cost with benefits, we are inclined to think that taking into account all the circumstances of crop production in the tropics, expenditure on farm manure is justified. Green manures are useful aids in supplementing farm manures, but they are not suited to all soils, and under conditions of poor rainfall may be distinctly prejudicial where moisture is lost through excessive transpiration from the green crop. With regard to their disposal in the soil it is believed by some that the plants should be allowed to wither after cutting before being turned in. Obviously, the problem needs further investigation since when turned in withered much moisture will have been lost and the soil moisture drawn on to assist in decay, the succeeding crop not infrequently suffering as a result; on the other hand, if buried fresh in such a way that capillary action is interfered with and air excluded, as often happens where hand labour is practised, the early development of the crop that follows will be hindered. Passing a roller over the green growth and then discing in the material seems to offer the most efficient means of disposal. It is interesting to note that all crops do not appear to be able to make use of

the soil nitrogen accruing when legumes are grown ; for example, at Woburn Experimental Farm, investigations carried on year after year show that neither wheat nor barley seem to benefit from the nitrogen left by a tare crop, and the reason is not yet fully understood. Work of this kind on tropical crops should produce valuable results.

On fertilizers and amendments, little need be said of the substances usually employed as such and which are familiar to all agriculturists. Attention may, nevertheless, be drawn to the influence some exert in relation to tilth and resistance to passage of implements. At Rothamsted, a saving in power varying up to 15 per cent. was obtained by chalking heavy land ; in this connection, the use of ground limestone is becoming more general and recent results with it on a sugar estate in Trinidad were referred to in Vol. I, No. 11 of this Journal. It was also found in Rothamsted trials that sulphate of ammonia used along with minerals was beneficial in this respect but that nitrate of soda acted the opposite way and increased the power requirement. Crop plants themselves may act as tilth improvers or otherwise. On newly broken land for example, a deep rooting legume will be found most useful. In the West Indies, the growing of Uba cane on soils of poor physical texture thus replacing other varieties not adapted to such soils should prove beneficial. Unfortunately, as Uba cane has to be burnt before being harvested much organic matter is thereby lost ; to offset this to some extent, the last crop of ratoons might be turned in instead of being allowed to mature. On the other hand, the bad after-effects of a crop like sorghum both on the crops that follow and upon the physical condition of the soil have been frequently observed, especially under dry conditions. These bad effects, it may be noted, do not persist, else the growing of sorghum on a large scale would probably have long since ceased. Recent work on the problems as reported in the *Journal of the American Society of Agronomy*, Vol. XVI, No. 11, indicates that a toxic body is formed during the decomposition of the sorghum stubble which is soon volatilized or itself decomposed ; while it is active, however, the flora responsible for the generation of carbon dioxide is, to a large extent, killed off, and with accessation of carbon dioxide production, deflocculation of the soil takes place—the opposite effect of liming.

In respect of rotations generally, methods of crop production in the tropics do not often lend themselves to definite rotation practices similar to those favoured in temperate climates. The reasons are mainly economic in nature and it is hardly necessary to discuss them here. It is sufficient to say that the benefits to be derived from some form of crop rotation are no less in the tropics than elsewhere, from a soil management point of view. In any case, it may be confidently stated that the value of a practice so easy to adopt under most conditions as the growing of a leguminous cover crop periodically on soils subjected regularly to monocultural cropping, cannot be over-estimated, even as a weed control measure. This aspect of the subject was dealt with in *Tropical Agriculture*, Vol. I, No. 4.

Space permits only a brief reference to erosion and soil wash. When it is calculated that over 400,000,000 tons of soil is carried to the sea annually from American territory, that 11,000,000 acres of land have been abandoned and that over 4,000,000 acres have been actually destroyed by

erosion, the magnitude of similar losses in the tropics can scarcely be doubted. As the surface soil is principally involved under ordinary conditions of soil wash, the loss of humus and humic substances—by far the most important constituents of soils and the most difficult to replace—gives rise to the greatest anxiety. The problem is now receiving considerable attention, notably in Ceylon and the eastern tropics, where forest land has been cleared to make way for rubber, tea and other crops. Even under arable conditions such losses may assume important proportions where adequate measures are not taken to check the ravages of storm water and floods.

In conclusion, the system or systems of soil management adopted will always be influenced by the law of diminishing returns and the varying conditions governing crop production. Using sugar as an illustration, the two extremes of Cuba and Hawaii may be cited. In the former, no system of soil management may be said to exist and production per unit of land is low; in the latter, most intensive methods are practised and the yield per unit of land, high—18 tons of sugar per acre being recently reported. The future of the two methods both agriculturally and economically will be watched with very great interest. Between these extremes there are a large number of cases where economic conditions are not so clearly defined and where a middle course seems more desirable, in keeping also with the requirements of permanent agriculture. For them, the question of how much or how little to spend on the land in order to get the best results financially is not easily answered. In solving problems of this kind, the need is for the closest co-operation possible on the part of those concerned.—Tropical Agriculture, Vol. II, No. 2.

SUPERPHOSPHATE FOR ROOTS.

A type of manuring that almost always pays for itself is the use of superphosphates for the root crop. This manure has a marked effect on the rate of root development; it causes the young plant to push ahead, and goes far to ensure a good growth in difficult seasons. Indeed, so successful has superphosphate proved in promoting root growth, that farmers use it on all root crops, including mangels and potatos, and sometimes apply considerable quantities per acre. There is evidence to show that these larger dressings are better split up over the rotation rather than given in one quantity to the roots. For superphosphate has another effect; besides increasing root development it promotes earlier seed formation. This property is of great value when cereals are grown in high-lying or backward districts; but it is not wanted for the root crop where, indeed, it would have the disadvantage of checking growth before the plant had really finished for the season. It appears wiser therefore, to give moderate but not large dressings of superphosphate to the root crop, and to give a dressing to the cereal crops, especially to the barley in which the seeds are to be sown.—Queensland Agricultural Journal, Vol. XXIII, Part 2.

PESTS AND DISEASES.

ERADICATION OF NUT GRASS.

N. A. R. POLLOCK,

Northern Instructor in Agriculture.

Nut Grass (*Cyperus rotundus*), Nat. Order Cyperaceae: One of a family of plants popularly known as Sedges.

Bailey, in his "Queensland Flora" describes some sixty-five species of Cyperus, several of which present a somewhat similar appearance, when growing, to nut grass, but fortunately are not pests like that species.

In the early stages of growth the appearance of several species is much alike, but later, when the flowering stems and flowers appear, the resemblance to a large extent ceases. Nut grass stems are rather slender, rising to a foot or a little higher, the upper portion of which is three-sided, the flowers being of a rich brown colour, the spikelets of which are borne in clusters on the stems. The species can always be distinguished by the nuts, which are bitter flavoured and borne on slender under-ground stems like widely separated beads on a string. Another species, *Cyperus esculentus*, or "Chufas" produces nuts somewhat similar to nut grass, but these are borne on single stems massed round the base of the plant and are sweet to taste, while the species is not a pest like nut grass but possesses economic value.

Nut grass is popularly supposed to reproduce from seed, but no authentic instance is recorded of plants being raised from seeds, which in many trials have been found infertile. Reproduction is effected from nuts and probably portions of the underground stem, which are distributed by the cultivating implements, the cloven hoofs of animals, or other mechanical agencies. It occurs widely in most tropical and sub-tropical climates over the globe and is more particularly plentiful on alluvial soils. Usually on virgin soils the nuts occur to within a few inches of the surface, but on cultivated lands will be found to the depth of the cultivated soil or as deep as the hole from which a stump has been taken and then filled in with soil. Nuts planted at a depth of some feet can be calculated to grow to reach the surface, so that no ploughing under can be considered as a means of extermination.

Nut grass is a decided menace to successful cultivation, since its growth is so rapid from the food supplies stored in the nuts as to smother out most crops, especially those of a low growth. Many strong-growing crops of more or less tall growth, such as sugar-cane, maize, sorghums, &c., are successfully grown in infested land, more especially in the cooler parts of the year, but their success is largely dependent on extra cultivation, which, in a wet season, cannot be effected as often as would be desirable.

The eradication of nut grass, economically, over an extended area is a problem which has not yet been solved and which does not appear possible of solution.

There are several means of eradication, but so far all are costly, or insist on a portion of the land whilst under treatment remaining unproductive or largely so over a term of years. Nut grass will thrive in dense shade and may be eventually smothered out by a dense-growing crop over two or more years. It may also be killed out by poisoning, fermentation, or burning processes which are only applicable to small patches on account of cost, but which, from the fact that from these patches a whole field would become infected, must be treated or fenced off to allow of the larger area being worked profitably. The following systems have been tried with success on small areas :—

SALT.

Apply the cheapest salt obtainable at the rate of 1 lb. to the square foot as a top dressing and allow it to remain undisturbed until all has been dissolved by rain and carried into the soil—repeat if any fresh shoot occurs. The effect of this treatment is that the land will be poisoned for other crops by the salt and the land will be of no value for some years until the major portion of the salt has been leached out.

ARSENIC.

The same remarks apply as to the effect of salt on the soil except that arsenic will be much more difficult to get rid of. Continued sprayings of the nut grass with a solution of arsenic or other weed killer would be prohibitive on account of the time necessarily taken up while the eradication of the arsenic from the soil would still have to be taken into consideration.

MOLASSES.

At the Agricultural Conference, at Gatton College in 1899, Mr. W. Gibson, of Bundaberg, is credited with the statement that he eradicated a patch of nut grass by pouring a few casks of molasses over it. Where the molasses is obtainable very cheaply, as in the case near a sugar-mill, its use in the eradication of nut grass is well worthy of trial. It is suggested, in applying molasses with this object in view, that the ground containing the nut grass be broken up for 6 in. or so in depth and molasses mixed with water in equal quantities, or two of water to one of molasses poured on until the soil is saturated. The fermentation of the water and molasses will be great and the destruction of the nuts might be expected.

STABLE MANURE.

A patch of nut grass was eradicated at the Acclimatisation Society's Gardens, Brisbane, years ago by placing a thick heap of fresh manure over it. The fermentation and heat engendered together with the total exclusion of light could be calculated to eradicate the pest, but some long time would necessarily be taken and the incident is merely related as one of passing interest.

PIGS AND POULTRY.

Any means whereby the foliage of nut grass can be entirely prevented must in time cause the death of all nuts and roots. Thus, if poultry are kept enclosed in sufficient numbers to eat off every green shoot as it appears, or if pigs are styed or the soil is so trampled that no green growth is possible, the same result would be achieved as if a floor or other light-obscuring structure was built over it.

PAPER MULCH.

It is possible much assistance towards eradication may be possible by the use of paper mulch in growing certain crops, which system has been much extolled in the recent few years. This paper is bought in rolls, which are laid on the ground and pegged or weighed down, the plants to be grown being planted by making a small hole in the paper. The success of the system with pine-apples has been demonstrated, but it remains to be seen if the same measure of success will be achieved with other plants, since the pine-apple plant is partly epiphytical. The exclusion of light and the prevention of growth of the nut grass by means of the paper mulch should have some effect, and might be tried by farmers on infested patches with tomatos or crops grown similarly.

FIRE.

At the State Farm, Home Hill, during clearing operations some time ago, a patch of nut grass some 20 ft. across was discovered, which was eradicated in the following manner :—The land had been ploughed before the nut grass had been observed. The soil of the infested part was dug up and turned over with shovels, and logs, branches, etc., from the clearing near by hauled on to the patch, making a good pile. This was then fired and resulted in the destruction of all nut grass on the burnt portion. It will be necessary where this is attempted to see that there is a certain amount of moisture in the soil, as it is considered the generation of steam assists in killing the nuts and roots.

INSECTS.

Some species of a Coccid insect are parasitical on nut grass. One, *Antonina australis*, has been spoken of as successful in New South Wales, and it has been observed in operation at Home Hill. The *Antonina* is closely allied to the Cochineal insect, but performs its work below the ground on the nuts, on which it appears as a white dusty part, exuding a blood-coloured liquid on being pricked with a pin. The effect of the insect is to destroy the nuts and subsequently the plant, which, when attacked, shows a yellowing and unhealthy appearance of the leaves, which afterwards die off. To eradicate nut grass by infestation with this parasite, it must be left two or three, if not more, years undisturbed, and the patch must be thickly infested with nut grass in order that the insects can easily travel from nut to nut. The foregoing treatments are only applicable to small areas, since the cost would be prohibitive over any large area, wholly or partly infested. On such an area the only feasible method is to endeavour to smother the nut grass out by dense, quick-growing crops, occupying the ground for long periods or planted in quick succession.

SMOTHER CROPS.

Kikuyu Grass.—Pennisetum clandestinum is considered to be the best grass to give success in this direction, but it must not be grazed or cut, and it must be allowed to occupy the ground at least three years.

Buffalo Grass.—Stenotaphrum americanum should also be successful. This grass, frequently used for lawns, must not be confused with Buffalo Couch, a name frequently given to Carpet grass, *Paspalum platycaule*, which latter is not recommended.

Beans.—The Lima Bean and also the Lab Lab, when grown without support, will cover the ground with a dense mass of vine and will last practically two years, smothering out any growth that does not grow higher than nut grass. A certain amount of profit might be derived from this crop by hand-picking the pods for use green, or in the case of the Lima or Haricot beans when ripe.

Velvet Beans.—Beans of this family form a dense growth and are valuable for hay or green forage. According to the variety they could be expected to cover the ground from five to eight months, when they should be ploughed under or harvested and another smother crop planted immediately.

Sorghum.—Sacchaline or other tall-growing varieties of sorghums sown broadcast rather thickly, using 30 to 40 lb of seed to the acre, would form a dense growth and prevent any other growth while occupying the ground. In the North this crop could be expected to last uncut for two years.

Field Peas or Vetches.—These would be grown only in the winter months, when the nut grass does not make very much growth and would, with cereals such as wheat, barley, &c., be crops to grow between the crops previously mentioned, which succeed better in the warmer months.

When smothering out nut grass by growing crops, it is important that the crops be continuous, so that the nut grass has as little breathing space as possible.

ENTOMOLOGICAL CONTROL.

Mr. Edmund Jarvis, Entomologist, Bureau of Sugar Experiment Stations, Meringa, North Queensland, supplies the following additional information on the subject :—Whilst Acting State Entomologist for Queensland during 1913, I was asked to investigate certain methods of using a parasite (*Antonina australis* Green) for destroying nut grass at Bundaberg, where it was said to be doing excellent control work.

The following notes are from my report, published in December, 1913 :—

The introduction of this insect has evidently been attended with highly beneficial results, affording valuable evidence of its usefulness.

Mr. F. L Nott states that, about three years ago, he obtained a small bag full of infested grass roots from Mr. E. Lane, who had told him of the insect's habits.

He planted pieces of these roots among his nut grass in a row, alongside a fence, at intervals of about 20 ft. apart, and finding upon examination a few months later that the parasites were spreading rapidly, was encouraged to infect other patches.

He started these experiments on 1½ acres, and at the present time has no continuous areas under this weed, and had practically destroyed all the nut grass on 20 acres of land. His soil is red volcanic, of a heavy nature.

Mr. Nott volunteered the following information, the truth of which was confirmed by my own observation :—

(1) That he has never found these coccids on roots of sugar-cane or fodder grasses, although often using the former as a smother crop.

(2) That the parasites thrive best on land that is fairly open and allowed to remain undisturbed; but in consolidated soils or roadways, &c., spread with difficulty.

The plan of procedure adopted and found successful is as follows:—

Pieces of infested nut grass are planted in rows across the area to be treated from 40 to 50 ft. apart, and 20 ft. from plant to plant each piece being placed about 3 in. below the surface against a flourishing clump of the weed. Operations are then suspended for a few months to allow the coccids to become established and extend a few feet from the infected centres, after which the ground is ploughed, harrowed, and planted with a cover crop of lucerne, sugar-cane, or pasture.

No cultivation is permitted until at least twelve months after the death of the green tops, as the parasites are still at work destroying the lower roots, and should be allowed time to reach and kill every nut.

Cultivating amongst the newly-established colonies is, I think, a drawback to the above method, but while doubtless killing a larger percentage of the insects, would, at the same time, ensure their even distribution to all parts of the field, thereby saving the hand labour entailed by closer planting.

(1) Why have several previous attempts to utilise this parasite for destroying nut grass proved unsatisfactory elsewhere?

(*a*) The land may have been disturbed too soon after treatment, thus causing exposure and death of the majority of coccids.

(*b*) Possibly soil conditions were unfavourable in some instances, the parasites are most likely unable to penetrate deeply in heavy, compact clays, or stiff wet soils, and in such cases the lower nuts might remain uninjured.

(*c*) Neglecting to plant a cover crop, or introducing the parasites during an unfavourable season, or when in a dying condition, brought about, perhaps, by prolonged exposure or damage during transit, would also tend to result in failure.

(2) Will these coccids, after exhausting the supply of nut grass attack other plants?

(*d*) This is a matter for further reserach, but evidence, so far seems to favour the supposition that their range of dietary is very limited. I examined the roots of sugar-cane and a few grasses, including "Buffalo Couch," growing among a mat consisting of dead nut grass leaves, which had been killed by this parasite, but found them unaffected.

(*e*) In 1904, Mr. W. W. Froggatt published the following information on this heading:—"Of course, there is always the danger that a root-infesting coccid may change its habits and attack other than its natural food-plant, and this was pointed out to our correspondents anxious to try experiments. To me this danger appears to be slight in this instance, as after two years the nut grass *Antonina* has not been found upon any other roots; and, secondly, that none of our grass or root crops are allied to or like the underground rhizomes of this obnoxious sedge. Again, among the described species of this genus, all of them seem to attack only one kind of food-plant."

(*f*) Many insects are very exclusive in matters of the diet, will sooner perish than eat unpalatable food. Some of the cochineal insects for example, which are closely related to the parasite under consideration, are confined to a single species of prickly pear and cannot be induced to subsist on other species of genus *Opuntia*.

I see no reason why the services of this insect should not be successfully utilised for the purpose of destroying nut grass in Queensland in districts where soil conditions are favourable to its spread; and provided that Mr. Nott's method of treatment be adopted, it seems reasonable to assume that the results achieved at Bundaberg should be obtainable elsewhere. —Queensland Agricultural Journal, Vol. XXIII, Part 1.

SOME NOTES ON RATS AND MICE AND THEIR SUPPRESSION.

The Ministry's Technical Adviser for Rat Destruction, Mr. E. C. Read, was invited to contribute a paper to be read before the Public Health Congress at Johannesburg in November, 1924. In the course of his paper Mr. Read remarked that rats and mice have always been amongst man's deadliest enemies, working silently in the dark to destroy his nourishment and damage his health. It is now known that the black rat was the cause of the frequent outbreaks of plague, which culminated in this country in the Great Plague of London in 1665. It was indeed long ago felt that some connection existed between rats and plague, and as early as the reigns of Henry VIII and Elizabeth statutes ordered rat and mouse destruction under the supervision of the church-wardens. In 1902 the Local Government Board ordered rat destruction in West Suffolk on account of a small outbreak of plague in the district.

A report by Major Kuhnhardt, of the Indian Medical Service, estimates that there are at least 800 millions of rats in India, each rat consuming at least 6 lb. of grain annually and defiling much more. Major Kuhnhardt estimates that in the last 20 years the loss to India is equal to £1,242,500,000, or five times India's national debt before the War, together with the death through plague of more than half a million people yearly.

Rats ruin furniture and clothing by gnawing holes for material for nest building, and cause fire through biting holes in gas pipes and destroying the insulating covering of electric wires. They also make holes in the embankments of waterworks, irrigation reservoirs and sea walls, thus leading to enormous damage and loss of life. Undoubtedly there will have to be a universal war against rats and mice, but the difficulties of such a campaign, are enormous. The rat is an ingenious creature that is not easy to catch and it is difficult to get people interested in a crusade against it. Even in England we know how indifferent many are as to their own welfare in the matter.

The important part that rats and mice play in the dissemination of disease amongst animals is now generally recognised. Trichinosis, etc., are spread by rats and mice, which harbour more parasites than any other known creature. It was not general knowledge until after the outbreak of the world conflagration that lice were the carriers of the germsof Spotted Fever (*Typhus exanthe-matieus.*)

Rat Destruction Orders in Great Britain.—Owing to the submarine warfare a million acres of pasture were ploughed up in England and used for growing grain and other food-stuffs. It was, however, not at first realised that this new source of nourishment was the determining point for a large increase in the rat and mouse population of the country. It is well known that the natural density of the rat and mouse population of a given area is determined by the available food supply. The realisation of this fact led to the Rat Order of 1918, and the amended Rat Order of 1919, both issued by the Ministry of Food, and it was in connection with these Orders that the systematic destruction of rats was commenced in England in 1919. The Rats and Mice (Destruction) Act, 1919, which came into force on 1st January, 1920, is the resultant permanent legislative measure on the subject. It is the earnest desire of the Government to see that rats and mice are destroyed and to help those authorities entrusted with the enforcement of the Act.

To this end a research laboratory was established and a small staff of technical assistants engaged to visit all parts of England and advise and instruct local authorities and the public generally on the safest and most efficacious methods of destruction. In connection with the research laboratory was a small factory where baits were prepared, and arrangements were completed to supply H.M. Office of Works, controlling thousands of buildings throughout the country, the admiralty, the War Office, the Ministry of Munitions, and other Government Departments. The research laboratory and factory have now been closed.

Some years ago the destruction of rats and mice was discussed at the Royal Sanitary Congress at Birmingham, where the room provided for the purpose could only accommodate one-third of those who wished to be present. At an Annual Meeting of the Sanitary Inspectors' Association at Margate the interest in the subject was also so acute that a subsequent special meeting of officers under the Act was held to discuss matters. When the question of rats was first brought before the meeting of the various authorities interested it was generally greeted with laughter. There are still a number of local authorities in England whose members are chiefly recruited from the farming community and who have not hitherto realised the importance of the suppression of rats and mice in their own personal interest, but it is expected that in due course we shall have all the local authorities in England acting in uniformity. The Government has reserved to itself powers to enter in and have the destruction carried out in case of default, but it is hoped that such an extreme course will not arise.

Many English local authorities have appointed whole-time rat officers, all ex-Service men, and rat and mouse destruction is being carried out on sound economic lines. The onus of destruction is, of course, not removed from occupiers of premises. The rat officer's primary duty is to see that such destruction is effected. In some cases the local authority, which, in the case of a defaulting occupier, has power to enter and undertake the necessary destruction, keeps a small staff of trained ex-Service men for this purpose and the cost of the services rendered is borne by the occupier. Thus many such schemes are self-supporting.

Early in the campaign it was realised in England that modern methods of publicity and propaganda were essential to awaken general interest in the matter. In 1919 a small exhibition was held at the Royal Zoological Society's Gardens, of all known media for rat and mouse destruction. In connection with this exhibit hundreds of practical tests were made and it was conclusively proved that the raticides advocated by the Ministry of Agriculture and Fisheries, *viz.*, barium carbonate and red squill, were not only the safest poisons, but also the most efficacious. The results of these tests have been published in a brochure issued by the Royal Zoological Society.

Rat weeks.—Then "rat weeks" were inaugurated. Three rat weeks were held in the winter of 1919-1920. They were popular and successful. In one county over 30,000 dead rats were picked up, and as it is rarely more than 10 per cent. of the numbers actually killed that are found it can be reasonably assumed that over a quarter of a million rats were killed in this one county during the winter.

In order to obtain the greatest possible simultaneous action throughout England, and also to remind occupiers of their obligations, it was decided to hold a rat week annually, and the first week in November is the time for this slaughter. It is quite realised, however, that continuous war must be waged against the rapacious rats and mice and that our primary duty is to see that ships do not import fresh stocks into the country to take the places of those destroyed. To this end the Ministry of Agriculture is co-operating with the Ministry of Health as to the fumigation of ships.

A typical example of an infested area was a northern port frequented by food ships from the East. As soon as these ships were emptied the rats on board (they are black and straight from the endemic plague lands) left the ships and did not return because the outward freight consisted solely of iron and steel. In this port even the Post Office, a so-called "rat-proof" building, harboured destructive and dangerous black rats from the cellars to the attics.

Examples of Rat Clearances and Damage Done.—Detailed accounts of rats killed need not be given, but an example of a town near London may be quoted. The Town Clerk and the Chief Sanitary Inspector solemnly informed Mr. Read that the town was practically rat-free. Yet 8,000 rats have actually been picked up in 10 months in the town! As to damage done, many hundreds of pounds' worth of valuable foodstuffs were destroyed weekly in a foodstore in the Midlands. Under the Rat Officer's direction rats were destroyed and the place rat-proofed.

In a colliery town every roll of cloth in a large clothier's was recently bitten because the premises were not rat-proofed when re-built, although the local Rat Officer pointed out the necessity of this being done.

A Multiple shop concern states that 300 of their 400 shops were troubled through rats. Imagine the loss of good food when cheeses are hollowed out by rats in one night!

In a south midland town three shops were infested by rats—a corn chandler's, a grocer's and a shoe repairer's. The corn chandler said that loss through rats was at least £100 per annum. Destruction cost £1. The grocer's loss was put at £125 per annum, and destruction cost £2 2*s*. The shoe repairer said he did not think they did any damage. One night the uppers of three pairs of boots were eaten away. The shop owner suffered a loss of £7 10*s*.

On a large farm in Surrey the damage done by rats to corn alone 1918-1919 was at least £1,000. In addition there was damage to buildings. Systematic action was taken, and an average of 250 rats were killed in each of four stacks. In 1919 -1920 an average of 8 rats were killed in four stacks; no damage to buildings. One can insure property against all kinds of risks, and should consider money spent on rat and mouse destruction as both a personal and national insurance. Each rat in the country costs £1 a year to keep. Imagine the personal and national loss of wealth occasioned by lack of vision in destroying these human enemies. The Consumers' Council of the Ministry of Food, in a considered report on the rat question said that £10,000,000 would be well spent in destroying this pest in England. Be that as it may, any money properly spent on such destruction bears immediate return to food saved and possible future loss through disease.

As will be seen from the foregoing the economic importance of rat repression is at the moment the chief incentive for action in England and Europe generally. It may not be long before proofs are forthcoming that rats and mice are also the carriers of other infections fatal to man and beast which should give a further impetus to rat and mouse eradication. We may now briefly describe on general lines, how such a campaign should be carried out.

Methods of Destruction.— A war against rats and mice is like every other conflict. Good staff work is essential to success, and the first step in the operations must be a survey. The rat infested area must be inspected and records made of the infested places. If dwelling houses, food stores, slaughter-houses or similar premises are the habitations of rats it is essential to render them as rat-proof as possible. Where the properties are drained the drains must be in order and not permit of rats entering the premises. The proper disposal of trade waste, such as empty food packages, is essential, as these often form attractive haunts and food supplies to rats and mice. House refuse and sewerage plants require constant vigilance. One must always bear in mind that the rat population of any area is determined by the amount of shelter for breeding purposes and of food supplies for existence. Not until the preliminary sanitary work is finished should systematic attempts be made to clear an area by poison, gas, etc.

Close co-operation with adjacent areas in any rat repressive work is imperative, and when the actual destruction is to take place work should commence from the confines of the infested area and proceed to the centre.

Of the various methods of killing rats and mice, poisoning and gassing are the most suitable for preliminary attacks, trapping and hunting being employed as supplementary methods.

Poisoning can be used with care almost anywhere, and if properly carried out is the surest way of quickly eliminating large numbers of rats. Until recently arsenic, phosphorus and strychnine were generally employed in baits, but such strong poison baits are not always desirable, especially if ignorant persons or animals can obtain access to them, or poultry, dogs, cats or pigs eat the poisoned rats. As a substitute for these poisons barium carbonate preparations in various forms have been found cheap, effective and comparatively safe, the poison itself having no repellent taste. Safer still is red squill, which is generally put on the market in the form of a

liquid extract and sold under various fancy names. Even better results have been obtained in many cases with squill preparations in biscuit, cake or powder form, and a combination of wet and dry red squill baits would probably be useful in a tropical climate.

The virus method, or artificial infection with disease, is one on which to keep an open mind, but at the moment, in Mr. Read's opinion, barium carbonate and red squill poisons give much better results.

Poisonous gases are being increasingly employed for rat destruction. Sulphur dioxide generators are used by local authorities to destroy rats on town refuse dumps, etc., in England. Under certain conditions calcium cyanide (very poisonous), calcium carbide and carbon bi-sulphide can be used for the purpose.

The success of any treatment must not be judged by the number of dead rats found, particularly when barium carbonate or red squill is used, but by the amount of bait taken, and by the gradual reduction of the nuisance.

Radical rat destruction entails great efforts and costs money. Unfortunately the serious damage done by these pests is often not realised either by the authorities concerned or the community at large. An efficient continuous campaign of repression is not only an economy but a necessity, with sustained effort it is possible to combat the rodent population, pitting human intelligence against the ubiquity, pertinacity and fecundity of these disease carriers.—The Journal of the Ministry of Agriculture, Vol. XXXI. No. 11.

SOFT ROT OF PINE-APPLE.

The following is a Summary of an article on the "Soft Rot of Pine-apple in the Philippines and other Countries" by Emiliano F. Roldan of the Department of Plant Pathology, Philippine Islands, appearing in the Philippine Agriculturist, Vol. XIII. No. 9.

The results may be summarized as follows :

(1) The soft rot of pine-apple is a new disease in the Philippines.

(2) The disease is destructive to fruits in storage and to piles of slips when conditions are favourable. The disease, however, has not been found to cause much damage in the field, as yet.

(3) The fungus responsible for the pine-apple rot in the Philippines is identical with *Thielaviopsis paradoxa* von Hohnel, the cause of the pine-apple rot and pine-apple disease of sugar-cane in Java, and in the Hawaiian Islands, and the coconut stem-bleeding disease in Ceylon.

(4) The soft rot of pine-apple disease of sugar-cane, and coconut stem-bleeding disease caused by *T. paradoxa* are present in Hawaii, Java, West Indies, India, Ceylon, Southern United States, and the Philippines.

(5) The *Thielaviopsis* occurring in the Philippines is pathogenic on banana, mango and sugar-cane.

(6) The disease may be controlled chiefly by avoiding injuries and collecting and destroying suspected hosts infected with fungus and by handling the fruits carefully in order to avoid formation of bruises, scars, and wounds.

(7) The fungus is able to force its way into fruits with or without wounds if conditions are favourable.

(8) No test was made on varietal susceptibility of pine apple in the Philippines.

CEYLON AGRICULTURE.

MATARA DISTRICT AGRICULTURAL COMMITTEE.

Proceedings of the 3rd Meeting of the District Agricultural Committee held on 9th February, 1925, at the Matara Kachcheri at 10 a.m.

Present.—Mr. G. S. Wodeman, Assistant Government Agent, in the Chair, and the following members:—Messrs. F. Burnett, Divisional Agricultural Officer, A. T. Reeve, Plant Pest Inspector, E. J. Buultjens, G. Altendorff, D. Samaraweera, Mudaliyars W. A. Amarasekera, S. W. Illangakoon, H. E. Wickramaratne, W. A. Perera and W. A. Wijesinha.

Minutes.—Read and confirmed Minutes of the meeting held on 21st November, 1924.

Agricultural Experiments.—The Divisional Agricultural Officer spoke at length on the desirability of opening experimental plots to try various methods for improving agriculture. The object he said could be best achieved by the members of the Committee undertaking experiments on their own lands as an object lesson to their neighbours, and communicating the practical results of these experiments at the meetings He also explained that the results of different manures used should be recorded separately to ascertain their efficacy which varies according to the soil and plantation. This information would afford useful data especially in view of differences in soil and climatic conditions in different parts of this country.

Paddy Experiments.—Mr. Burnett also emphasized the point that the selection of seed paddy was an important factor in increasing the yields of crops. The best method of seed selection was to collect the best ears of paddy keeping the different varieties separate.

Stagnant and Excessive Water.—He also dwelt on the expediency of draining stagnant water in fields before cultivation commences to ensure a good crop.

The Chairman pointed out the necessity of instructing the Irrigation Headmen through the Mudaliyars as to the adoption of better methods of intensive cultivation and concentrate their duties to the improvement of paddy cultivation. He said that he had endeavoured to instil into them from time to time on circuit a sense of their duties and responsibilities towards the proprietors of lands who have elected them.

Poultry Farming.—He also dealt briefly on the subject of poultry farming which is a profitable concern and said that experiments in this line should be undertaken.

Agricultural Competitions.—Resolved that Mr. G. Altendorff and Mr. D. Samaraweera be associated with the Divisional Agricultural Officer in the final judging of paddy transplanting and garden competition plots.

Pests and Diseases Proclaimed under the Plant Protection Ordinance.—Mr. A. T. Reeve, Plant Pest Inspector, explained that kitul palms grown on gardens are also affected by the pests known as Red Weevil and Black Beetle, and suggested that the existing regulations published under Section 9 (2) of Ordinance 10 of 1924 in Gazette No. 7429 of 31st October, 1924, be amended so as to include any kind of palm.

(a) Resolved that steps be taken to recommend to Government the substitution of the word "palms" for a coconut palm in the regulations.

(b) Mr. Reeve further pointed out that only Weligam and Morawak Korales and Wellaboda Pattu have been proclaimed as infested areas in Gazette No. 7431 of 31-11-1924 for purposes of the regulations relating to the Black Beetle and Red Weevil and emphasized the necessity of bringing the rest of the division under the operation of the rules.

(c) Resolved that Four Gravets, Kandaboda Pattu and Gangaboda Pattu be brought under the operation of the rules.

Kuruni Measure.—Mudaliyar W. A. Amarasekera mentioned that the resolution passed by the Committee "that as the Kuruni is widely used as the measure of capacity it should be standardized by law as the equivalent of ⅛th bushel" was submitted to the Food Products Committee of the Board of Agriculture, and that it was duly accepted, the words "as the equivalent of ⅛th bushel" being deleted.

Appreciation of the Services of the Chairman.—Mr. Samaraweera expressed on behalf of the Committee their appreciation of the services of the Chairman and their regret at his impending departure. He stated that he had taken a keen interest in the work of the Committee and the development of all agricultural pursuits in the District.

The Chairman expressed his thanks for the sentiments expressed.

NUWARA ELIYA DISTRICT AGRICULTURAL COMMITTEE.

Minutes of a meeting of the Nuwara Eliya District Agricultural Committee held at the Kachcheri on the 2nd March, 1925.

Present.—The Chairman, Messrs. S. W. Bennett, T. J. Wilson, Ratemahatmayas of Walapane, Kotmale and Uda Hewaheta, President, V. T., Uda Hewaheta and Walapane, Messrs. N. K. Jardine, Plant Pest Inspector, G. E. J. Hulugalle, Acting Divisional Agricultural Officer, and the Hony. Secretary.

Letters regretting absence were received from Messrs. C. C. Wilson and D. C. Jayawardena.

Minutes of meeting held on the 12th July, 1924, were read and confirmed.

Papers re (1) Constitution of the Board, (2) Co-operative Societies and (3) Agricultural Shows and Competitions were tabled.

Divisional Agricultural Officer's letter No. 2511 of 19-9-24 re school gardens was discussed and it was resolved that this Committee considers it

desirable that school gardens should have greater facilities afforded re water service, equipment, etc., and that Government be asked to provide the necessary funds to give effect to the proposal.

Tea Gardens Competitions, Kotmale.—Resolved that competitions be held for the whole of Kotmale and that the Ratemahatmaya and the Divisional Agricultural Officer be requested to report progress, with recommendations they may have to make with regard to future shows, for consideration at next meeting.

Walapane Agricultural Show.—The Chairman explained that the date fixed for the Show was the 25th April, 1925, at Harasbedde, and the progress made up to date.

Experiment Station for Pundaluoya.—Mudaliyar Edrisinghe dwelt at length on the subject giving details of the scheme. Resolved that this Committee is in entire agreement with the proposal and that the Chairman be requested to be good enough to take steps to acquire the necessary land from the proprietors of Sheen Estate for the erection of an experiment station at Pundaluoya.

Cultivation of Cotton.—Mr. T. B. Wettewe, Ratemahatmaya of Walapane, dealt on the satisfactory results obtained in 1922 and 1923 from the small areas planted in cotton and urged that Crown chenas be given on easy terms to prospective cotton cultivators. After discussion in which the Chairman and the Divisional Agricultural Officer took part, it was resolved that one acre of Crown land, adjoining Udamadura circuit bungalow be set apart for experimental cotton cultivation, that the Walapane Village Committee do undertake to erect a barbed wire fence and that the D.A.O. be requested to put the Agricultural Instructor in charge—the bungalow-keeper to do the cultivation and to appropriate the profits. Further resolved that the D.A.O. be requested to report progress at the next meeting of the Committee.

Jak Cultivation in Uda Hewaheta and Kotmale.—Mr. P. B. Andarawewa, Ratemahatmaya, urged that jak be cultivated on road reservations. Mr. U. B. Unamboowe, Ratemahatmaya, detailed steps taken by the Kotmale V. C. to encourage the plantation of jak. Resolved that the V. C. C. of Kotmale, Uda Hewaheta and Walapane be requested to encourage the cultivation of jak on terms similar to those prevailing in Kotmale *i.e.* (1) 2 acre blocks, (2) Cost of fencing and plants to be met from V. C. funds, (3) Crown land to be given free for the purpose, (4) the plantation to be the property of the V. C. The Chairman explained that Mr. Andarawewa's proposal would, if adopted, cause damage to roads.

Minutes of Meeting.—On Mr. Jardine's proposition it was resolved to send copies of minutes to all members.

Granary at Harasbedda.—Mr. Bennett inquired how matters stood with regard to the proposed granary at Harasbedda. The Chairman explained that the scheme had not materialized, that he would go into the question and have contributions refunded, if it was not practicable to start the granary.

PADDY CULTIVATION COMPETITION IN SIYANE KORALE EAST OF COLOMBO DISTRICT.

Mr. J. P. Obeyesekere of Batadola, Veyangoda, considered that the cultivators in the villages around Veyangoda did not give paddy cultivation the attention it requires, despite the assistance rendered them by the Agricultural Department and recommended that a Competition might stimulate better cultivation methods. He offered for the acceptance of the Department two prizes of Rs. 150/- to be offered annually for competition for a period of five years, to be continued for a further period, if found necessary.

This very generous offer was thankfully accepted and arrangements were made for a paddy cultivation competition for the villagers of Siyane Korale East in Colombo District, for the following prizes :—

For cultivations of one acre or over in extent	1st prize ...	Rs. 75·00
	2nd ,, ...	,, 25·00
For cultivations of more than ¼ acre in extent but less than one acre.	1st prize ...	Rs. 30·00
	2nd ,, ...	,, 20·00

and the successful competitors to be also awarded certificates by the Department of Agriculture.

Eleven cultivators entered for the competition for 1924 and it is reported by the Agricultural Instructor, Veyangoda, who had the work in hand, that the competition was keen, and that good work had been done by the cultivators. The fields entered for the competition were regularly inspected by the Agricultural Instructor.

The judging was carried out by Mr. J. P. Obeyesekere, the Mudaliyar of the Korale, the Agricultural Instructor and Mr Paulin E. Pieris.

At the final judging marks were allotted for the following agricultural operations, viz. ploughing, manuring, weeding, attention to ridges, levelling of fields and the general condition of crop at harvest.

The prizes were awarded to the following competitors :—

1st set :	R. M. Themis Appuhamy of Meegalla ...	1st prize
	C. P. Amerasinghe of Meddagama ...	2nd ,,
2nd set :	D. B. Jayasinghe of Ellakkala ..	1st prize
	W. D. Arnolis of Welegedera ...	2nd ,,

The thanks of the cultivators and of the Department in particular, are due to Mr. Obeyesekere for this generous encouragement. Arrangements are being made to hold a similar competition this year and it is expected that the number of competitors will greatly increase.

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CO-OPERATION.

MODEL BY-LAWS FOR A PROVIDENT FUND OF A PRIMARY VILLAGE CO-OPERATIVE SOCIETY.

1. A fund shall be established to be called the Co-operative Society's Provident Fund under the auspices of the Society.

2. The objects of the Provident Fund shall be to promote thrift, and to give accumulated savings and a donation to its members at old age, viz., ...years or, in the case of death, to their nominees or heirs-at-law.

3. The Provident Fund may be raised in any or all of the following ways, viz., by entrance fees, by receiving deposits and by donations and any money received as interest on investment of the fund. This fund shall not be liable for the debts of the Society.

4. Only members of..... ..... Co-operative Society who are under the age of.....years are eligible for election as members of the Provident Fund. Any member of ....Co-operative Society desirous of becoming a member shall make his application in the prescribed form

which can be had on application. The application should accompany the baptismal or birth certificate or the horoscope, and shall be elected by the majority of the votes of the Managing Committee.

5. Every member of the Provident Fund on being elected shall pay an entrance fee of.....cents (for working expenses), and thereafter a monthly deposit of.....during the term of his membership. The monthly contribution shall be payable at the end of each month.

6. A member shall be allowed one month's grace to pay his monthly contribution, after which he shall be liable to pay a fine of.....cents for each month in default which shall be debited to his account, and if he shall make default for six months, he shall cease to be a member and any money standing to his credit in the books of the Provident Fund shall be paid back to him without any profits or interest, provided in the event of sickness, a member with the written sanction of the Committee previously obtained may leave his monthly deposits unpaid for a period of six months; and on his recovery from illness his arrears shall be paid as determined by the Committee.

7. A subscriber who has ceased to be a member under by-law No.6 may be re-elected under by-law No. 5 for valid reasons, and if he ceases to be a member by default again under by-law No. 6 he is not eligible for re-election again.

8. Every member of the Provident Fund shall be given a Pass Book in which all his transactions with the fund shall be entered.

9. A member of the Provident Fund of the age of.....years shall be paid, within three months of his attaining the.....year, in full the sum of money lying to his credit in the books of the Provident Fund, together with a donation to be computed at the rate of.....per each and every member of the Provident Fund.

10. In the event of the death of a member his nominee or heirs-at-law shall receive a donation of..... per head of members on the roll, who are liable for payment at the date of his death, provided that such a member shall have been a member of the Provident Fund for a period of twelve months, together with any moneys due to the credit of the member in the books of the fund. Donations paid under this by-law and by-law No. 9 shall be collected by special calls or debited to the amount standing to the credit of each member. If the funds standing to the credit of any member are not sufficient to meet the demand at any time, the Committee shall have power to make a special call.

11. Whenever the Committee of management after the decease of any member makes any payment under by-laws Nos. 9 and 10 to any person or persons who at the time appear to the Committee to be entitled to the same, such payment shall be valid and affectual against any demand made upon the fund or the Committee of management by any other person or persons.

12. On the death of a member the nominee or heirs-at-law of such deceased member shall be paid in advance a sum not exceeding half of the amount the member is entitled to have from the Society, or Rs. , whichever shall be the less, to meet the funeral expenses of the deceased member pending the settlement of the deceased member's claims on the fund, as per by-law No. 10.

13. The Provident Fund shall be managed by such members of the Managing Committee of.....Co-operative Society as become members of the Provident Fund; three shall form a quorum.

14. The Managing Committee of the Provident Fund shall transact business of the Provident Fund at meetings specially convened for the purpose, and the minutes of such meetings shall be written in a book kept

for the purpose. The following books, viz., Minute Book, Members' Register, Cash Book, Ledger, Journal, and any other books as may be found necessary shall be kept under the direction of the Managing Committee in connection with the transactions of the Provident Fund.

15. The Secretary, the Treasurer, and the Auditors of the Society shall be the Secretary, Treasurer, and Auditors of the Provident Fund.

16. The books of the Provident Fund shall be open for inspection of any member of the Provident Fund on his giving three days' notice in writing to the Secretary.

17. The funds of the Provident Fund shall be deposited with a bank approved by the Registrar, and all withdrawls shall be signed by the President and Treasurer or Vice-President and Treasurer. No investments shall be made without the written sanction of the Registrar.

18. A statement showing the receipts and payments, profits and losses assets and liabilities of the Provident Fund shall be submitted to the Annual General Meeting of the Society.

19. Every person who ceases to be a member of..... ....Co-operative Society shall automatically cease to be a member of this fund save as provided in regulations 9 and 10, and every member who ceases to be a member of the fund by resignation or otherwise shall be entitled to receive only the sum of money lying to his credit within three months of his ceasing to be a member.

20. The power to alter, rescind, or amend a by-law or to enact a new one is invested in the Special General Meeting of..... .....Co-operative Society.

21. Two members of the Managing Committee or any two members of the Provident Fund shall have power to convene a General Meeting of the members of the Provident Fund through the Secretary of the Society for the discussion of any subject concerning the management of the Fund. Proceedings of such a meeting shall be placed before a General Meeting of the Society for consideration.

MODEL BY-LAWS FOR A PROVIDENT FUND OF A CO-OPERATIVE SOCIETY IN A GOVERNMENT OFFICE.

By-laws as approved by the Managing Committee of the above Society.

1. A fund shall be established to be called the..... .....Co-operative Society's Provident Fund under the auspices of the society.

2. The object of the Provident Fund shall be to ensure to its members the benefit of a donation to be paid on final retirement from the Government Service and the Society, to themselves or to their nominees or heirs-at-law.

3. The Provident Fund may be raised in any or all of the following ways, viz., by entrance fees, by receiving deposits and by donations, and any money received as interest on investment of the fund. This fund shall not be liable to the debts of the society.

4. Only members of the .... Co-operative Society are eligible for election as members of the Provident Fund. Any such member of the..... Co-operative Society desirous of becoming a member shall make his application in the prescribed form and shall be elected by the majority of the votes of the Managing Committee.

5. Every member of the Provident Fund on being elected shall pay an entrance fee of.....cents, and thereafter a monthly deposit of Re..... during the term of his membership. He shall also pay in accordance with by-law 8 such payments called special calls from time to time.

6. Any member of the Provident Fund who fails to pay his deposits for a period of three consecutive months and any special calls falling during the period, shall forthwith cease to be a member of the Provident Fund; and any money standing to his credit in the books of the Provident Fund shall be paid back to him without any profits or interest, provided in the event of sickness or absence from the Island, a member with the written sanction of the Committee previously obtained may leave his monthly deposits and special calls unpaid for a period of six months; and on his recovery from illness or return to the Island his arrears shall be paid as determined by the Committee.

7. Every member of the Provident Fund shall be given a pass book in which shall be entered all his deposits.

8. On the retirement of a member of the Provident Fund, from the Government Service, he shall be paid, within three months of his retirement, in full the sum of money lying to his credit in the books of the Provident Fund for a period of twelve months, and with a donation to be computed at the rate of.....per each and every member of the Provident Fund, and to be collected by special calls from them.

9. On the death of a member the nominees or heirs-at-law of such deceased member shall be paid in advance a sum not exceeding..... ....to meet the funeral expenses of the deceased member pending the settlement of the deceased member's claims on the fund as per by-law No. 8.

10. The Provident Fund shall be managed by such members of the Managing Committee of the..... Co-operative Society as become members of the Provident Fund.

11. The Managing Committee shall transact business of the Provident Fund at meetings specially convened for the purpose, and the minutes of such meetings shall be written in a book kept for the purpose. The following books, viz., Minute Book, Members' Register, Cash Book, Ledger, Journal, and any such other books as may be found necessary, shall be kept under the direction of the Managing Committee in connection with the transactions of the Provident Fund.

12. The Secretary, the Treasurer, and the Auditor of the Society shall be the Secretary, Treasurer, and Auditor of the Provident Fund.

13. The books of the Provident Fund shall be open for the inspection of any member of the Provident Fund on his giving one day's notice in writing to the Secretary.

14. The funds of the Provident Fund may be invested in a manner approved by the Managing Committee with the written sanction of the Registrar.

15. The Secretary, the Treasurer, or the Auditors may receive bonuses as authorized by the Annual General Meeting of the Society.

16. A statement showing the receipts and payments, profits and losses, assets and liabilities of the Provident Fund, shall be submitted to the Annual General Meeting of the Society.

17. Every person who ceases to be a member of the..... .....Co-operative Society shall automatically cease to be a member of this fund save as provided in regulations 8 and 9, and every person who cease to be a member of the fund by resignation or otherwise shall be entitled to receive only the sum of money lying to his credit within three months of his ceasing to be a member.

GENERAL.

ORGANIZATION OF SCIENTIFIC RESEARCH FOR THE PLANTING INDUSTRIES.*

BY THE DIRECTOR OF AGRICULTURE

Your Excellency, the Chairman of the Planters' Association and Gentlemen,

I have to thank your Chairman for this opportunity to address you and I have chosen a subject which has been somewhat to the forefront during the past few months. In the short time at my disposal I propose to crystallize in brief the principles which should guide our policy in regard to the important subject of scientific research for the staple agricultural industries of the Colony. I shall confine myself this afternoon to the three main planting industries—Tea, Rubber and Coconuts.

There is general agreement that the development of the agricultural resources of any country is one of the functions of its Government. This duty of Government is the more necessary in a country where the main industries are agricultural and where the Revenue is derived chiefly from these industries. In Ceylon, this duty of the State to agriculture has been recognised. Provision has been made for agricultural research for the past twenty-five years and for the publication of the results obtained. Within the past few years additional provision has been made as the Government recognises that it is to its advantage to assist maximum crop production from any industry and that it is its duty to ensure that an agricultural industry is in a position to protect itself against epidemics of pests and diseases. There has however been a feeling in the Colony, and this feeling has been growing, that further provision for research is necessary and particularly for research applied to particular problems. In the tea industry, there is a recognition of the need of more fundamental research in connection with the physiology of the tea plant, soil investigations, manuring problems and with the use of leguminous cover or shade crops. There is also a demand for research on the manufacturing side of the industry and for investigations into various problems concerned with quality. In rubber, further information is demanded in connexion with the production of raw rubber, the budding of rubber and with various diseases—such as brown bast and leaf-fall—of the rubber tree. In the coconut industry the physiology of the palm requires investigation, the yielding capacity of different varieties should be investigated, the effects of manure studied and problems connected with the manufacture of copra, desiccated nuts and oil tackled.

A beginning has been made in connexion with the rubber industry under the Rubber Research Scheme, and proposals for the provision of research for the Tea and Coconut industries have been under discussion. The provision of funds for the Coconut Research Scheme was deleted from the

* Address delivered before the Planters' Association of Ceylon at the Annual General Meeting held on March 13th, 1925.

last Budget and in consequence the Tea Industry has now under consideration the desirability of inaugurating a Scheme of Research independent of Government assistance or control.

It is well therefore at this stage to review the situation in regard to the respective responsibilities of Government and of the industries towards research. As stated previously, all modern Governments recognise their duty towards agricultural research. In most countries this is interpreted to mean that the State shall undertake investigations which will ensure maximum crop production by proper cultivation, selection of varieties and by the control of pests and diseases. It is held that the Industry should be responsible for the application of the results of research to its own needs and for all technological investigations connected with the manufacture and utilisation of the commercial product. When it is considered desirable that these two types of investigation should be conducted under one scheme of research, arrangements are invariably made for work on a co-operative basis. This co-operation takes the form either of a grants-in-aid by Government to Research Institutions or by grants from the industry concerned to official Departments of Agriculture. In the United Kingdom State assistance takes the form of grants to a number of independent Research Institutions governed by Boards of Governors or Trustees. The work is left to the institutions concerned and the State is content with the minimum of inspection. Sometimes these grants are for limited periods and are renewable only after reports of inspections made for the State have shown that the work accomplished has been satisfactory and the work in hand warrants the continuation of the grant. Such grants are made to Agricultural Research Institutions and have also within more recent years been issued through the Department of Scientific and Industrial Research to specialized Research organizations established by the various large industries of the country. For instance, the Rubber and Tyre Manufacturers have established a Research Institution. They have received a grant for 5 years and are likely to have this renewed for a further period. In such cases, it is the professed intention of Government gradually to reduce its financial contribution when the "Million Fund" becomes exhausted and as the industries become more and more organized in regard to Research. Grants to Agricultural Research Institutions are not expected to decrease if the finance remain satisfactory. Examples of industries making grants to official departments are to be found in the Empire Cotton Growing Corporation's grants to various tropical departments of agriculture, to the Indian Central Cotton Committee's contributions to Provincial Departments of Agriculture of India working on cotton and to some examples from Java, Mauritius, etc. The Tea Experiment Station in Java has risen from the beginning made in 1893 when certain tea estates guaranteed the salary of an agricultural chemist who worked exclusively on tea problems in the Government Laboratory for Agricultural Chemistry. The Rubber Research Scheme of Ceylon was likewise started by certain estates in this island who provided funds sufficient for the maintenance of a chemist to work solely upon rubber problems. The Mauritius sugar planters agreed to a special cess on sugar exports for the establishment of a College of Agriculture at which sugar chemists and technologists should be trained, and the agricultural industries of Trinidad offered a special cess on their products for the inauguration of the Imperial College of Tropical Agriculture.

Let us consider what has recently been done for agricultural research in countries close to us. In India, the cotton industry repeatedly urged the necessity for more agricultural and technological research for the improvement of cotton in India and a Government Committee urged that a central fund for cotton research be established by means of the levy of a cess of four annas per bale on cotton exported from British India. This has been agreed to by the Government of India and the Indian Central Cotton Committee has been legally incorporated by Ordinance and provision made for the collection of a cess upon all Indian cotton consumed in the Indian mills and upon all cotton exported. This committee is providing for the establishment of a Central Agricultural Research Institute for cotton work, for agricultural research in co-operation with Provincial Departments of Agriculture and other institutions and for Technological Research in a special Institute established in Bombay. In India, likewise there is the Scientific Department of the Indian Tea Association financed by the industry and subsidized by grants-in-aid by the Government of India and by the Governments of Bengal and Eastern Bengal and Assam.

In Malaya, the establishment of a Rubber Research Institute financed by a special export duty of 10 cents per picul on rubber exports has recently been sanctioned by the Secretary of State for the Colonies and the Federal Council. In Java the Central Rubber Station and the four district rubber Experiment Stations are financed by subscriptions from estates and similar financial arrangements exist for the Tea Experiment Station.

There are indications now-a-days that the commercial world is tending to move from an age of competition between firm and firm to one in which the element of competition will be merged in emulative co-operation. Industries are beginning to organize themselves and demand that the results of research work should be available for the whole. In consequence they feel that it should be paid for as a whole. When an industry is flourishing it is prepared to subsidize research to a considerable extent, but when times are bad and every item of expenditure has to be carefully scrutinized the subscription to a research association is often removed from the budget. The time is not yet when research will be recognised as an insurance and as such a first charge upon the budget. It is therefore necessary that the provision of funds for research work should not be solely dependent upon voluntary contributions.

Fundamental research in any industry often takes years and years of constant work before results can be secured. Sufficient provision for continuity of work has to be assured. Good work cannot be expected from short term grants nor from workers recruited only on short term agreements. It is therefore essential that before research work is undertaken for an industry security in regard to finance should be assured. It is likewise generally accepted that those responsible for the contribution of the funds should have the control of their expenditure.

In Ceylon, the Government is directly interested in the provision for agricultural research. Its revenue depends upon the condition of its main agricultural industries. It is incumbent upon the Government to assist in assuring maximum crop production and in protecting its Revenue from loss by reason of its agricultural export—industries being seriously affected by

pests and diseases. On the other hand, it is not called upon to undertake technological research or to provide the machinery for specially applied investigations. These should be provided by the industries themselves.

In Ceylon, it therefore appears to be necessary for co-operation between the industries concerned and the Government if full provision is to be made for the full measure of research demanded by the Industry and recognised as being essential. The ultimate form of such co-operation may be a question for discussion, but personally I favour the form of a grant-in-aid from Government funds and a special cess upon all exports. Such a proposal in respect of the coconut industry was not sanctioned by the Finance Committee at the last Budget, mainly I believe because certain members of the Legislature thought that the whole of the work should be carried out by Government and because others were jealous of passing out of their control any funds in the shape of grants-in-aid. Both these objections were legitimate criticisms but I am certain that it may be possible to convince those members that the whole of this work is not the duty of a Government Department of Agriculture without a special subsidy from the industry and that there are plenty of precedents for the payment to Research Institutes of Government subsidies in the form of grants-in-aid. There are adequate means whereby the rights of the tax-payers, as represented by their members in the Legislative Council, can be safeguarded and the expenditure of funds provided along proper channels can be assured. The grants-in-aid come up for scrutiny annually at every Budget and what better safeguard in regard to their expenditure can be required than the assurance that the funds will be expended by an Incorporated Board of Trustees selected by the industry itself and directly responsible to that industry for an account of its stewardship. The tea, rubber and coconut industries have reached such a stage of development that they now require separate research organizations if the whole of their needs are to be met. These I consider should be formed in co-operation with the existing Department of Agriculture which has already done much research work in connection with the pests and diseases of these crops and with green manure crops and has valuable records available. The establishment of special experimental stations for field experiments and trials and the provision of technological research are the most urgent requirements of the planting industries at the present time. Before these can be started special funds should be provided by the industries themselves. It is very essential that there should be no overlapping of work and it is likewise very essential that some assurance be given as to the amount of funds which will be available for a definite number of years. Problems of considerable complexity await solution and these will only be solved by uninterrupted work. If funds are likely to vary from year to year these problems will not be tackled and much fundamental research will in consequence be neglected. The industry may provide funds by means of special export duties but stability is more likely to be secured if Government co-operates by means of grants-in-aid. It is the duty of the Government to pay special attention to an agricultural industry when it makes out a good case for additional research and to assist it with funds in order to ensure continuity.

FORESTRY AND ITS APPLICATION TO THE GOLD COAST.

H. W. MOORE,

Assistant Conservator of Forests.

Forestry is seldom a spectacular enterprise, and persons who come into contact with Forest Officers invariably put the question "What is Forestry?"

Forestry has been defined as the management of growing timber, in its broadest sense as the science, art and business of producing, reproducing and improving forests for forest purposes and of practising the most appropriate methods of harvesting, converting and disposing profitably of forest produce.

Apart from its business aspect, and particularly in the tropics forestry has a wider scope and is intimately bound up with the whole question of economic agriculture. So much has been written on the benefits indirectly derived from the existence of suitably situated forests and the influences they exert on the climate of a locality that it is only necessary to refer to them briefly here. Forests maintain, continuously, a higher atmospheric moisture content than any other crop; nothing has yet been discovered to surpass them either in their capacity for maintaining an equable flow in rivers and in protecting their sources or in protecting hill sides and preventing erosion and land slips; they make most suitable windbreaks and sanctuaries for bird friends of agriculture; they are the best means of reclaiming lands suffering from excessive aridity or denudation; in a one-crop country they are the best and cheapest means of preventing the spread of diseases injurious to that crop and, finally, they furnish the most convenient means of supplying the timber and firewood requirements of the population. Forestry, therefore, has a claim to consideration.

Man has been taught to believe that forest growth has been specially designed by an otherwise more or less beneficient Providence for his particular annoyance and so he designed the axe. There is no question about the utility of that particular implement but there is a possibility of its use being carried beyond the beneficial stage and becoming a menace to its users. Such a contingency is by no means unknown, time and again in the word's history has the excessive use of the axe taken away the means of livelihood from the people it has hitherto assisted. It is the function and privilege of forestry to step in before the axe recoils on its wielders or, to put it briefly, forestry and agriculture are interdependent and act conjointly in promoting and sustaining the progress of a country. It is not, therefore, in the best interests of any country to sacrifice the one wholly to the other.

Forestry, in spite of the benefits it may confer on the community is not popular and is generally looked on, if not as a menace to economic progress, at least as an unmitigated nuisance and its supporters as a band of ill-balanced fanatics. This may be due partly to the fact that while the occupation of large areas of land under forest is irritatingly obvious, the compensating advantages of conservation are not immediately apparent as long periods must often elapse before forests attain their maximum production, and partly to the general desire to exploit the land to the fullest extent, regardless of the consequences and of the interests of posterity.

In a country where there is no immediate shortage of forest produce or while the effects of excessive deforestation are not immediately apparent, forestry is of little interest and the general feeling is that the land can be more profitably utilised in growing other crops. Such a short-sighted policy may be successful for a time, but after the limit of useful deforestation is passed not only does indispensable forest produce commence to become scarce but the climate is progressively altered to the detriment of existing crops, necessitating the substitution of others. These substituted crops must be capable of surviving under more arid conditions and the process of substitution is repeated until the final effect of deforestation is attained, the production of desert conditions. The world is dotted with the results of excessive deforestation, examples of this progressive desiccation, are on record from Africa itself and may even be seen within the Gold Coast Colony where the gradual drying up of streams has necessitated the moving of whole villages.

Other countries have realised that forestry means something more than indiscriminate land grabbing in order to provide a play-ground for zealous foresters. Not only are its climatic effects recognised but also is the fact that the world consumes annually an enormous amount of timber and other forest produce and that this amount is steadily increasing with the general raising of the standard of living; this, in spite of the many materials now used where once timber and natural products were solely employed.

It does not require any strenuous mental effort to realise that if forests continue to be cut down without any attempt at conservation and replacement there will come a time when timber will be very scarce. This time is well within sight and as a result most countries have jettisoned their policies of indiscriminate deforestation and substituted policies of conservation. The United States of America, one of the most important sources of the world's timber supply has, for the last decade, prosecuted a vigorous policy of conservation and reafforestation; her neighbour and competitor, Canada, has taken stock of her resources with a careful eye to the future. France recognised the protective and productive value of forestry long before the war and her forests were a valuable asset during it, and it is well known that in her forest Germany had a valuable ally. England was handicapped by the meagreness of her home timber supply and the lessons then learnt have been subsequently applied.

The average inhabitant of this country who has travelled through the Colony and Ashanti and has seen what he supposes to be vast tracts of forest may be excused for believing that there is no great need at the moment for forest conservation. A closer investigation reveals the fact that many of these apparently forested areas are honeycombed with farms that are continually expanding, until now it may be generally said of the eastern half of this once wholly forested area that it is more farm than forest. This state of affairs appears to have been brought about since the introduction of cacao, *i. e.*, within the last 30-40 years. With the rate of expansion in the future being the same as it was in the past it is obvious that the coming generation will see the destruction of the remaining forests.

This country, for many years past and in spite of its vast resources of native timber, has been importing lumber. If that was necessary then how much more necessary will it be when all the accessible areas have been denuded of their forests and at how much greater cost when the world scarcity is more acute? It might be argued that because cacao is so much more valuable a product, bulk for bulk, than timber it is to the country's advantage to use all the available land for the cultivation of cacao. Lumber, however, is becoming increasingly expensive and all forecasts are unanimous in stating that it will continue to do so and it is conceivable that there may come a time when it might have paid this country better to have retained sufficient timber producing areas to meet the needs of its inhabitants.

Apart from the £. s. *d.* aspects of forests, they are necessary for the maintenance of the very industry they are being destroyed to make more room for. The influences that forests exert on the climate have already been mentioned and all these influences are necessary for the continued cultivation of cacao, a crop which cannot do without, a high atmospheric moisture content, suffers, in common with any other perennial crop, from alternating floods and drought, requires shelter from strong winds and is here subject to every disease known to science.

Continued deforestation has a cumulative effect on the climate and it is obvious that if cacao and allied crops are gradually deprived of the physical conditions necessary for their existence the desiccating process will bring the staple crops of the country to the point when they will begin to suffer and they will eventually die out altogether. The effects of excessive deforestation, it is believed, are apparent in some parts of the country already.

It seems so much simpler to maintain under forest certain areas that are necessary to protect the principal industry of the country and to supply locally the timber and firewood requirements of the people than either to exhaust that industry and then commence to establish another or to resort to costly reafforestation schemes after the damage is done and the country most needs its resources.—The Journal of the Gold Coast Agricultural and Commercial Society, Vol. III, No. 2.

IMPROVED VARIETIES OF TOMATOS.

Experiments made at the Agricultural College, Poona, with two varieties of tomato, as inter-crops between young fruit trees (figs or chikoos) have shown such improvement in yield, in one case at any rate, over the variety usually grown that it would seem wise that they should be more generally known.

The two varieties were known as "Great Baltimore" and "Bonny Best." They gave fruits of high quality and of good form and size. The skin was smooth and the colour most attractive, being rich bright red. The flesh was solid and there were few seeds. The flavour was agreeable. The average weight per fruit was 13 tolas (5·3 ounces.)

The results in weight of crop in 1923, in comparison with the local variety usually grown were as follows :—

Variety.	Yield per acre. pounds.
1. "Great Baltimore"	8,376
2. "Bonny Best"	16,259
3. Local Variety	9,220

The Horticulturist to Government, Agricultural College, Poona, will be pleased to supply a limited quantity of the seeds of these two American varieties to applicants. The "Bonny Best" is particularly recommended on account both of quality and high yield.—Indian Scientific Agriculturist, Vol. VI, No. 2.

VILLAGE CACAO GARDEN COMPETITION IN KANDY DISTRICT.

W. MOLEGODE

Agricultural Instructor.

During 1924 a Cacao garden competition was initiated for Harispattu—Tumpane Cacao area and the offer of two prizes of Rs. 60/- and Rs. 30/- respectively was made.

The competition was conducted under the rules governing the conduct of Cacao garden competitions of the Department of Agriculture.

Owners of more than 10 acres of land whether cultivated or uncultivated, nor Headmen above the rank of Aracies were eligible to compete.

In all 72 small gardens were registered as entering for the competition, but at the first visit of inspection 24 of these were rejected as not worth coming into the competition by reason of the very neglected conditions of the gardens and the Cacao. At a later stage the number of competing gardens were reduced to 28 by a process of elimination considering the amount of attention paid to the garden. For the final judging 12 gardens were selected and at the final judging the following two gardens were selected for the prizes.

Kumbukgahamula Watta, in Uduwawala, Harispattu, Cultivated by Theveren Kankany.....1st Prize

Kosgolle Watta in Dehideniya, Tumpane. Cultivated by Dehideniya Punchi Banda..... 2nd Prize

In awarding the prizes the following points were considered and marks awarded :—Pruning, Drainage, Shade, Loss by disease and squirrels, Method of planting, Method of Curing, Cleanliness of cultivation, Crop visible and admixture with other crops.

The object of the competition was to encourage better methods of cultivation and curing of village Cacao.

The competition aroused a fair measure of interest all round and great keenness on the part of a number of growers who entered their gardens for the competition. The fact that the competition is being repeated this year has added greater interest.

LIBRARY.

TROPICAL GARDENING AND PLANTING.*

The third edition of this Handbook, which has special reference to Ceylon, has just been issued. It has been re-arranged and largely re-written and there is certain to be a considerable demand for what has been looked upon as a standard work which could be recommended with confidence.

The present volume is divided into five sections consisting of 37 Chapters and is profusely illustrated with 400 half-tone blocks and three coloured blocks. The first section includes ten chapters of a general character dealing with soils, manures, propagation and cultural operations. The second section deals with ornamental trees, shrubs, pot plants, annuals, etc., while section 3 is devoted to fruits and their cultivation. The fourth section is the economic section dealing in brief with estate products, drugs, fibres, dyes and fodder crops while the concluding section includes chapters on common pests and diseases, the transport and packing of seeds and plants, recipes for jams and a Calendar of work for Ceylon.

The present edition is full of useful and practical information and should prove to be of very considerable value to all interested in agriculture or horticulture in Ceylon or the tropics generally. Every endeavour has been made by Mr. Macmillan to bring it up-to-date and based as it is upon nearly 30 years of tropical experience in the Royal Botanic Gardens, Ceylon, it should command a place in the library of every estate and home in the East.

CROP PRODUCTION IN INDIA.†

The volume by Mr. Albert Howard, the former Economic Botanist to the Government of India, is a record of the scientific work that has been done for the agriculture of India during the past twenty years. Many improvements in crop production has been made and sound work done in the distribution of seed and the investigation of many important agricultural problems. There remain, however, a number of problems which require solution before further advances can be made and these can only be dealt with if the active co-operation of the public is secured. Many of these problems are set out in detail as the object of the writer has been to stimulate further work and to attract enthusiastic investigators to these questions. The book is a most interesting one for those connected with agricultural investigations in the East and contains many indications as to lines of work which should prove to be productive of good. It is truly suggestive and should act as a stimulus to all workers who read it.

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* Tropical Gardening and Planting by H. F. Macmillan, F.L.S., F.R.H.S. Published by The Times of Ceylon, Rs. 25·00

† Crop Production in India by Albert Howard, C.I.E., M.A. Published by Oxford University Press, 10*s.* 6*d.*

MARKET RATES.

MARKET RATES FOR SOME CEYLON PRODUCTS.

(FROM THE CEYLON CHAMBER OF COMMERCE WEEKLY PRICE CURRENT, DATED 16th MARCH, 1925.)

NAME OF PRODUCE		CURRENT PRICE Rs. cts.	at	Rs. cts.	REMARKS
CACAO—(At Buyer's Stores)					
Estate—Finest	per cwt.	51 00	,,	56 00	
Do Medium	do	40 00	,,	53 00	
Do Common (Black)	do	15 00	,,	30 00	
CARDAMOMS					
All round parcel well bleached	per lb.	3 60	,,	3 75	
Do do medium	do	3 10	,,	3 60	
Special assortment 0 & 1 only	do	4 00	,,	4 10	
Seeds	do	3 95	,,	4 10	
Green	do	3 30	,,	3 60	
CINNAMON QUILLS—(At Buyer's Stores)					
Ordinary assortment (in bales of 100 lb. nett)	per lb.	0 68	,,	0 75	
No. 1	do	0 71	,,	0 78	
No. 2	do	0 69	,,	0 76	
No. 3	do	0 66	,,	0 74	
No. 4	do	0 63	,,	0 71	
CINNAMON CHIPS—Maradana, (At Buyer's Stores) (in bags of 56 lb. nett) per candy of 560 lb.		60 00	,,	75 00	
CITRONELLA OIL—(ex-Seller's Stores without packages) ...	per lb.	1 50	,,	1 65	
COCONUT—(Desiccated) Granulated goods (Delivered at Wharf or Buyer's Stores) ... ... Assortment: Medium 50 per cent. Fine 50 per cent. ...	per lb.	0 19¼	,,	0 20	
COCONUT OIL—					
White Oil .o.b	per ton	... ...	,,	575 00	
Ordinary Oil do	do	540 00	,,	547 00	
COPRA—					
Calpentyn	No. 1 quality per candy of 560 lb.	77 50	,,	80 75	
Estate	,, ,,				
Ordinary quality (Maravila)	,, ,,				
Cart Do do	,, ,,				
FIBRES—(At Buyer's Stores)					
Coconut Bristle No. 1	per cwt.	8 00	,,	9 50	
Do No. 2	do				
Coconut Mattress No. 1	do	2 20	,,	2 60	
Do No. 2	do				
Coir yarn, Koggala Nos. 4 to 9	do	10 00	,,	25 00	
Do Colombo Nos. 3 to 7	do				

PLUMBAGO		X. B. Rs. cts.		Rs. cts.	B. Rs. cts.		Rs. cts.	B. E. Rs. cts.		Rs. cts.
Ordinary Lumps	per ton	340 00	at	400 00	250 00	at	350 00	200 00	at	280 00
Chips	do	250 00	,,	350 00	200 00	,,	275 00	105 00	,,	225 00
Dust	do	175 00	,,	250 00	100 00	,,	175 00	60 00	,,	120 00
Do Flying	do	100 00	,,	145 00	75 00	,,	100 00	45 00	,,	75 00

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st MARCH, 1925.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1925	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	75	17	25	24	—	26
	Foot-and-mouth disease	473	308	395	1	76	1
	Anthrax	—	—	—	—	—	—
Colombo Municipality	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	250	60				—
	Anthrax	—	—	—	—	—	—
	Rabies	2	—				—
Cattle Quarantine Station	Rinderpest	—	—				
	Foot-and-mouth disease	12					
	Anthrax	57	†				
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	248	7	241	—	7	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	7	—	1	7	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	28	—	28	—	—	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	14	14	14	—	—	—
	Anthrax	—	—	—	—	—	—
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	394	—	394	—	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	83	40	64	11	8	—
	Anthrax	—	—	—	—	—	—
North-Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	422	113	417	—	5	—
	Anthrax	—	—	—	—	—	—
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	911	205	732	33	146	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	70	28	22	42	—	6
	Foot-and-mouth disease	71	21	58	—	13	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia		6	—	6	—	—

* Up to the end of February. Figures for March not yet to hand. † Figures for March not yet to hand.

M. CRAWFORD,
Acting Government Veterinary Surgeon.

Colombo, 7th April, 1925.

METEOROLOGICAL
MARCH, 1925.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	80·4	—1·0	81	6·8	W	77	7·33	15	+ 2·82
Puttalam	80·2	—1·0	80	4·4	Var.	117	9·61	11	+ 6·66
Mannar	82·6	—0·4	76	5·9	NE	164	2·88	8	+ 1·46
Jaffna	81·2	—1·6	76	5·8	SE	12 9	6·55	5	+ 5·41
Trincomalee	82·0	—0·6	76	6·2	E	154	4·82	9	+ 3·18
Batticaloa	80·8	0	82	4·0	NE	158	2·81	8	— 0·23
Hambantota	79·0	—1·4	84	5·3	Var	206	6·59	18	+ 4·30
Galle	79·4	—1·7	85	6·7	W	130	13·78	15	+ 9·43
Ratnapura	80·6	—1·6	80	6·3	—	—	18·41	23	+ 9·61
Anu'pura	80·5	—1·5	78	5·0	—	—	4·97	12	+ 2·25
Kurunegala	80·6	—2·3	74	7·4	—	—	13·48	15	+ 8·59
Kandy	76·4	—2·0	78	7·5	—	—	9·65	19	+ 5·75
Badulla	72·7	—0·7	82	7·0	—	—	11·88	21	+ 7·46
Diyatalawa	66·5	—1·1	76	7·8	—	—	11·13	22	+ 7·11
Hakgala	60·0	—0·2	87	8·0	—	—	10·44	17	+ 5·08
N.' Eliya	59·4	+0·3	78	7·2	—	—	5·60	18	+ 2·21

The first week of the month was comparatively dry, but a steady fall of barometer commenced on the 10th, and developed into a slight but fairly definite depression, with its centre south-west of the island, by the 12th. This moved northward, and by the 14th afternoon was over the north of the island. It subsequently moved further north, causing appreciable damage in the Jaffna peninsula as it went. It was followed by the usual aftermath of local thunderstorms, which were most in evidence on the 19th, and gradually diminished in frequency until the end of the month, when nearly all stations reported fine weather.

Rainfall totals for the month were above average in practically all cases. The excess was most pronounced at inland stations on the outer limit of the main hill country, and particularly so in the south-east, where Meeriabedde recorded 26·09 inches.

Stations in the Jaffna Peninsula were also well above their monthly average, with the help of some very heavy rain on the 13th.

In the central part of the hill-country and the remaining parts of the coastal low-country the rainfall was above average, but by less striking amounts. Noteworthy falls in a single day included Pallai, 15·12, Elephant, Pass P.W.D., 9·40, Chavakachcheri, 7·70, Point Pedro 7·50 and Vadamaradchi 7·26 inches.

The strength of the wind was on the whole above average and in a number of cases caused damage to property. In addition to the strong wind that occurred during the passage of the depression referred to above, noteworthy gusts were reported from Pathregalle (Kurunegale District) on the 20th, and from Palugaswewa (Chilaw District) on the 29th, the latter case, being accompanied by hail, which was also reported from the Ratnapura district on the 19th, and from the Deniyaye district on the 31st.

A. J. BAMFORD,
Supdt. Observatory.